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Amateur Radio

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EICO TRI-BAND SSB / AM / CW TRANSCEIVER · MODEL 753
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Who else but EICO

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73 Magazine

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October 1966

Vol. XLIII, No. 1

Cover by Sid Willis

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de W2NSD/1

never say die

de W2NSD/5Z4

This is being written while on "safari" in the remote wilds of northern Kenya. I put safari in quotes because the 1966 concept of a safari over here is probably quite different from anything you have in mind. It certainly is different from the stories I have read and movies I have seen down through the years of safaris. Perhaps I should disclaim here: readers who want only ham info in their ham magazine should turn to the next article because there is absolutely nothing of amateur radio to follow. Readers who have mistaken 73 for Holiday or Venture may be interested in the adventures of a newcomer to Africa.

The trip over here from Boston was supposed to take just one day. Jim Cotten W5PYI and Larry Frank WA6TCI arrived on Monday night and I picked them up in Boston and drove them up to the 73 headquarters for a day of getting acquainted. Larry had been with me in 1963 on the 73 tour of Europe. On Tuesday we finished our packing and had a long QSO with Robby 5Z4ERR in Nairobi. Robby answered a lot of our questions for us. When we finished our QSO with Robby we were called by 9Q5HF in Linga in the Congo. We are planning on visiting Ed after our safari and visit to Kenya. Ed assured us that we could visit the Congo in perfect safety. That was comforting.

Wayne with guides and waterbuck.

Jim Fisk WA6BSO/1, who is minding the button factory while I'm away, drove us all down to the airport Tuesday evening. We had gone to lengths to make sure our baggage was within the weight limit of 44 pounds each, providing they didn't weigh us with our hand luggage. Our flight was by Alitalia to Rome and then, with about a two hour delay, Alitalia on to Nairobi. With everything connecting right we should leave Tuesday evening and arrive in Nairobi the following evening. It took us three days to get to Nairobi.

The flight started off an hour late, making us a little nervous about that connection in Rome. They had oversold the tourist compartment and the three of us had to suffer through the ten course dinner and champagne of the first class section. The seats were much larger and roomier too, but not really comfortable enough to promote much sleep. We arrived the next morning in Rome rather pooped. OK, where do we find the Nairobi plane? The Alitalia people looked nervously at each other. Where is it? Well, you see, we er . . . ah . . . had to cancel that flight. Today is Wednesday and we think we will have another flight on Saturday. Certainly by next Tuesday. In the meanwhile you will be the guests of Alitalia. You will stay at a nice hotel with rooms and meals paid.

How about alternate ways of getting to Nairobi? No, very sorry, but we have checked that and all flights are fully booked. You'd best wait for our Saturday flight. Most of the people caught in this situation just gave up and went to the hotel. Not us. Jim grabbed an airline manual and started looking up possible ways of getting from Rome to Nairobi . . . via anywhere. Of the many possibilities the best seemed via Tel Aviv or via Athens. We tried for reservations on these two paths and both came through for us. We flipped a coin and it was Athens. That would get us into Nairobi by Friday noon.

(Continued on page 96)

NEW from International

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9mc EXCITER-DRIVER
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The SBX-9 Exciter-Driver and the SBA-50 Mixer-Amplifier provide the perfect combination for 50-54mc SSB operation. Performance, versatility and reliability are incorporated into this new SSB pair. A tremendous value at a low price!

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SPECIFICATIONS:
Mixer-Amplifier 50-54mc

Tubes:	6U8A Oscillator-Mixer 12BY7A Amplifier 6360 Linear power amplifier
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Output:	SSB single tone 10 watts
Controls:	On-Off Power PA Grid Tune PA Plate Tune PA Load Tune Metering Switch
Metering:	Oscillator 9mc Drive Buffer Grid PA Grid RF Out
Crystals:	Three positions, uses 3rd overtone 41-45mc range. Crystal frequency = final frequency —9mc
Misc:	Accessory socket provided for connecting keying circuit to SBX-9. Comes with three crystals. Specify frequency when ordering. For operation on 117 vac 60 cycle power.

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Integrated Circuits

How will they affect you?

Tiny integrated circuits are making a big noise in the electronics industry. In the past year or so, they've just about taken over the jobs once held by transistors in computers. Now IC's are creeping into consumer products like TV sets and portable radios; they may take them over completely in a few years.

So what are integrated circuits? What do they do? How are they different from more familiar electronic components? How are they used? And most important, how will they affect our hobby? I hope this article will give a short, if incomplete and oversimple, answer to these questions.

What are integrated circuits?

Integrated circuits are electronic circuits made from miniature electronic components mounted on small insulators. Some IC's have been around a long time. Remember the flat Couplates used in radios and TV sets? These small ceramic plates with resistors and capacitors printed on them can take the place of many larger individual components. Couplates are simple integrated circuits.

IC's can offer these advantages over conventional components and construction:

- Versatility
- Reliability
- Light weight
- Low power requirements
- Low cost per function
- High input impedance
- Wide frequency response
- Small size
- High gain
- Low phase shift
- Simple external circuitry
- Easy gain control

Possible disadvantages of IC's compared to conventional circuitry:

- Parasitic capacitances between components
- Parasitic transistors and diodes
- Only small capacitors can be used (under 500 pF)
- Only small resistors can be used (under 100 k)
- Inductors can't be included in IC's
- IC resistors aren't precision
- IC resistors have high temperature coefficient
- An individual can't design his own IC's
- "IC circuitry is different" complain some hams

But the IC's that are attracting so much attention now are different from earlier ones. They contain not only resistors and capacitors, but also diodes and transistors. These integrated circuits are of two types: *monolithic* and *hybrid*. A monolithic IC is formed from a single chip of silicon. Components and conductors are etched on its surface by clever photographic and chemical processes. The chip is mounted on a small terminal block with thin wires soldered from the proper places on the surface of the chip to the terminals. Then the whole assembly is mounted in a sealed case or dipped in plastic for protection.

A hybrid integrated circuit is basically a monolithic IC chip with small components made from thin films of nichrome or other materials mounted on its surface. These films can be used for components that can't be made from silicon, such as high-value resistors. Another name for this type of integrated circuit is *thin film*.

Most IC's have been made from silicon, but experimental ones have used other semiconductor materials. The transistors in present commercial IC's are conventional bi-polar devices, but various types of uni-polar transistors such as field effect transistors have been used. IC's using *FET*'s probably will become more popular as their prices come down.

It's easy to draw the schematic of an IC since it's composed of more-or-less conven-

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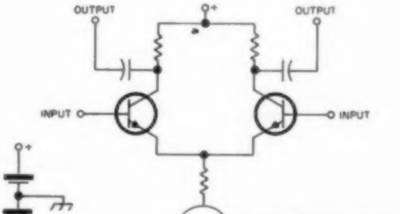

Fig. 1. Schematic of a very simple, but typical, type of integrated circuit.

Perish the thought Penelope . . .

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We've long since learned that the ham using Waters gear is a critical cuss, far removed from the ordinary. His respect for quality and performance is deep-seated and sincere. For him to keep pace with advanced thinking and up-dated equipment is as natural as transmitting a sharp signal. You simply don't make ordinary equipment for this kind of ham. Waters doesn't.

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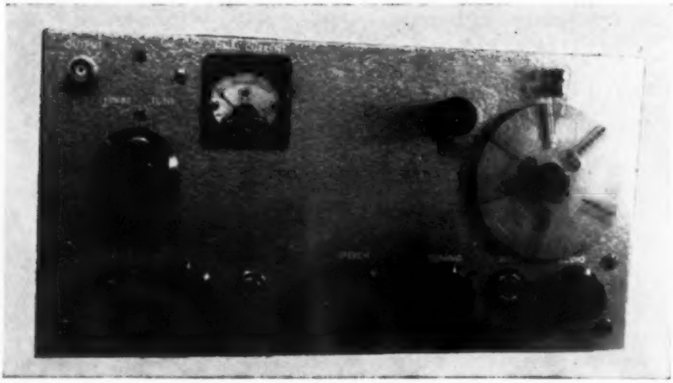


Ed Marriner W6BLZ
528 Colima Street
La Jolla, California

El Marrinero

A Portable SSB 80 m Transceiver

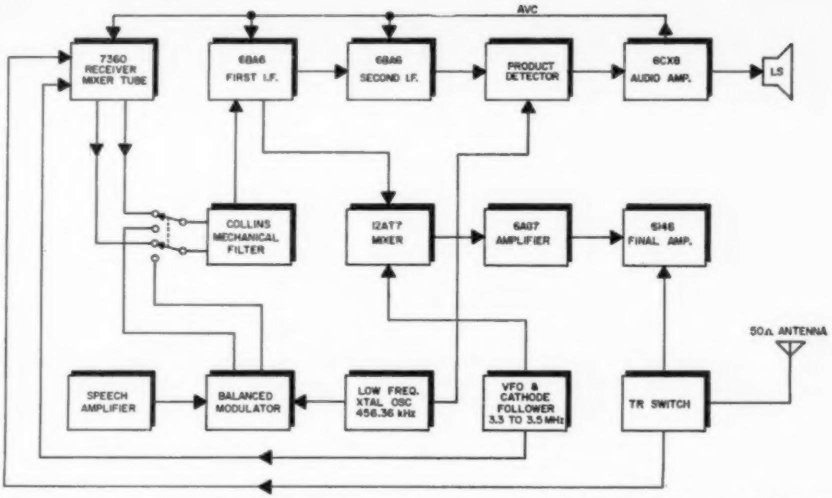
This is an 80 meter SSB transceiver for the man who hasn't everything. It has an input of about 70 watts, and is built out of old standard radio parts, partially because they are cheap. Call it a pre-historic monster if you wish; it works fine. The only argument for building this rig is that it is a complete unit with the power supply all on one chassis, and it is a little cheaper than buying a one-band kit. It might take a little too much experience for the average amateur, but the old soldering iron artists should not have too much trouble with the straightforward circuits.

The original idea for building this transceiver was to have something around the shack that could be taken on vacation trips without worrying that knocking around would destroy its resale value. The time spent building the rig, however, left some pensive thought on the future of amateur radio. Let's face it, gone are the days of building an oscillator-amplifier rig in one afternoon, it took several months to turn this one out. You have to be a real nut to build anything these days. It should not be too far in the future when all you have to do is go to the radio store and buy a transistor board all made up and just plug in the parts. Why not? All of the circuits are worked out and are standard.

There are today plenty of amateurs in all parts of the world who are not as lucky with their dollars as we in the U.S.A. They are also tied up with import taxes and the high cost of radio parts. They still are high up on the list of surplus part users, so this article will be a big help for them. This rig is small and came out about the same size as any transistorized rig using the equivalent power input. It should do the job for the boys overseas because it is portable, compact, and yet cheap. If this proves anything, we might say that the old parts still have some good qualities, and are still mechanically reliable, even though it may not be progress if that is what we must have in our radio magazines.

Theory

This SSB transceiver tunes from 3.75 to 4.0 MHz using a VFO made with the variable capacitor taken out of an ARC-5 transmitter for vernier tuning. The input to the transmitter portion is about 70 watts PEP, and the rig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PRODUCT DETECTOR
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LS
COLLINS MECHANICAL FILTER
12AT7 MIXER
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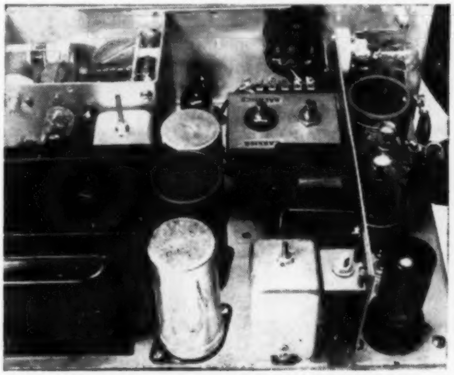
6146 FINAL AMP.
50Ω ANTENNA
SPEECH AMPLIFIER
BALANCED MODULATOR
LOW FREQ. XTAL OSC 456.36 kHz
VFO & CATHODE FOLLOWER 3.3 TO 3.5 MHz
TR SWITCH

Fig. 1. Block diagram of El Marrinero, a portable 80 meter SSB transceiver built by W6BLZ. The circuit is quite simple for a sideband transceiver. Optional VOX is shown in Fig. 6.

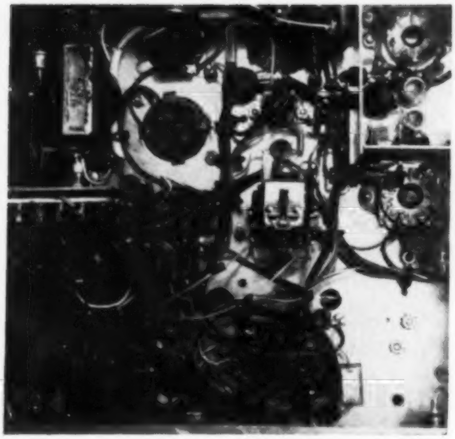
is all self-contained with the 700 volt power supply all on one chassis. It uses a Collins 455 kHz mechanical filter which can be obtained by sending $26.50 to Mr. Don Iacoboni, Collins Radio, 19700 San Joaquin Road, Newport Beach, California. Ask for the amateur type filter, F-455-FB-2.1 with a 2.1 kHz bandwidth. This unit is cheaper than the other filters used in commercial equipment.

Here is how the rig works: The block diagram is **Fig. 1**, the schematic **Fig. 2**. In the receiving section a 80 meter signal from the antenna passes through a TR switch composed of a 6 watt 120 volts lamp and two diodes, and is fed into the antenna coil. The tuned signal is then applied to the grid of a 7360 mixer tube directly without any rf stage. Here the signal is mixed with the VFO and comes out at 455 kHz and fed into the mechanical filter by two relay contacts. The input and output of the filter is tuned to 455 kHz by a fixed 130 pF capacitor across its input and output. After passing through the filter the signal is amplified by two stages of 6BA6 *if* amplification, detected in a product detector and then audio amplified. AVC is obtained by rectifying voltage from the first audio tube and applying it to the 7360 and the two *if* tubes. It is simple and effective.

In the transmit position the low frequency crystal oscillator (456.360 kHz) is applied to a diode ring modulator and combined with the audio speech. The output of this modulator is sent through the filter by relay contacts, and amplified by one stage of 6BA6 *if* amplification. The plate voltage is applied to this tube at all times because it is used in both transmit and receive position, while the second *if* tube is only used in receive position. After the signal comes out from the first *if* amplifier it is mixed with the VFO signal (3.3-3.555 MHz) in a 12AT7 mixer and comes out in the 80 meter phone band. (This include the Canadian portion) The five volts of rf produced by this mixer is enough to drive a 6AG7 driver tube that in turn drives a 6146 which has about 600 to 700 volts applied to its plate, at about 150 mA. The output signal is coupled to a coax 52 ohm line by tapping up from the ground end of the coil. This works satisfactorily and makes for simple tuning



Back view looking toward the front panel. The carrier balance pots were later moved to the front panel for operating convenience.



Bottom view. The base of the 6AG7 driver is shown in its shielded compartment.

compared to a pi network. A small antenna tuner can be made with broadcast type receiving capacitors, or fed directly into a di-pole or mobile whip type of antenna.

It should be pointed out here this rig can only be used on 80 meters because it is single conversion. The VFO being only 455 KHz away from the output signal would prohibit a tuned circuit from tuning it out on 7 MHz. It could be done with more tuned circuits. More tuned circuits are necessary as you increase in frequency to accomplish the same rejection.

Construction

This transceiver is built in a California Chassis cabinet LTC #470 which has included a chassis 5¾ x 11¾₆ x 8¾ inches. Layout is shown in **Fig. 3.** Since this rig was a breadboard there might be a better arrangement, and an experienced constructor might find it desirable to re-arrange some of the parts. If parts are placed in other positions be sure and keep the 7360 as far away as possible from any choke or power transformer field to prevent its being modulated. It is a good idea to keep the audio section shielded off from the diode rectifiers, and filter chokes. Diode rectifiers often develop large transient signals which can be picked up in a high gain audio amplifier if it is too close. This receiver is absolutely clean from hum and diode switching noise in the parts placement shown.

The constructor might have thoughts of using a variable capacitor to gang tune the slug coils for the mixer-driver-amplifier. If this is done good shielding will have to be used to prevent picking up rf causing oscillations. Keep even the slug coils small. Using fixed 250 pF mica capacitors across the coils a tuning range across the 80 meter phone band is satisfactory without too much falling off of drive without re-adjustment of the slugs.

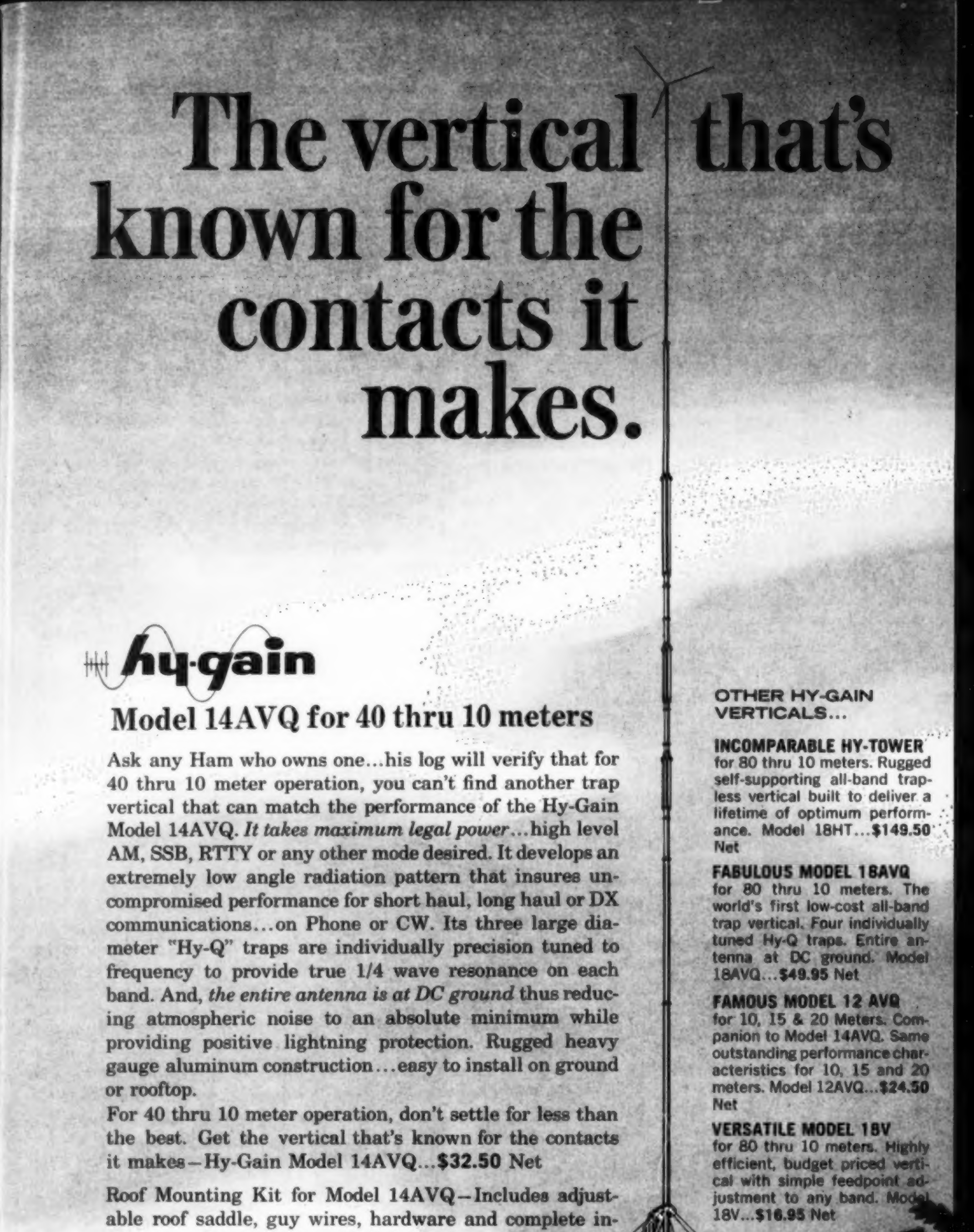
One of the main feature of this transceiver is that the power supply is mounted on the chassis. More space could be saved if a transformer could have been obtained with a bias winding, but this transformer only cost $2.95, and it has a filament 6.3 volts at 9A, and the secondary handles 210 mA.

Construction was started by mounting the power supply in one corner of the chassis and wiring it so that the available voltage could be used to check out the circuits as they were completed.

Next in line was building the VFO and then finishing the receiver portion. Nothing was finished until the receiver was operating, and then construction was continued on the transmitter section.

Low frequency crystal oscillator

Since most amateur operation on 80 meters SSB is on the lower sideband, and because crystals are expensive, only the 456.360 kHz crystal was used. This crystal can be obtained by writing to Mr. P. M. Freeland, International Crystal Co., 18 North Lee street Oklahoma City, Okla. and asking for the special amateur crystal for this frequency in a F-609 holder. It will cost about $8.00. If this is too much the other solution is to buy a 50 cent surplus crystal marked Channel 46 and edge sand it down to the proper frequency. Sometimes by buying a number of these surplus crystals, one will be found that is good enough, or far enough down on the slope of the filter that it will sound okay. The crystals are spot welded to the crystal with small wires, but if a holder is made with a clothespin and held carefully the edge can be sanded on sandpaper enough to increase the frequency. These crystals are more sluggish to make oscillate and a 60 mH rfc may have to be used in the grid of the 6BH6 oscillator rather than the 2.5 mH shown. It is a good idea to use the 6BH6 as some tubes just don't work. Many oscillator circuits were tried and this particular circuit gave the most output. At first the 30 pF capacitor was not used from the grid to ground but the oscillator did not come on every time. Various values were tried and the 30 pF seemed to be the best compromise. The crystal oscillator puts out 15 volts of rf and it was found that 6-9 volts were necessary for the product detector. If less voltage is applied to the detector loud signals do not mix. The cathode follower was needed



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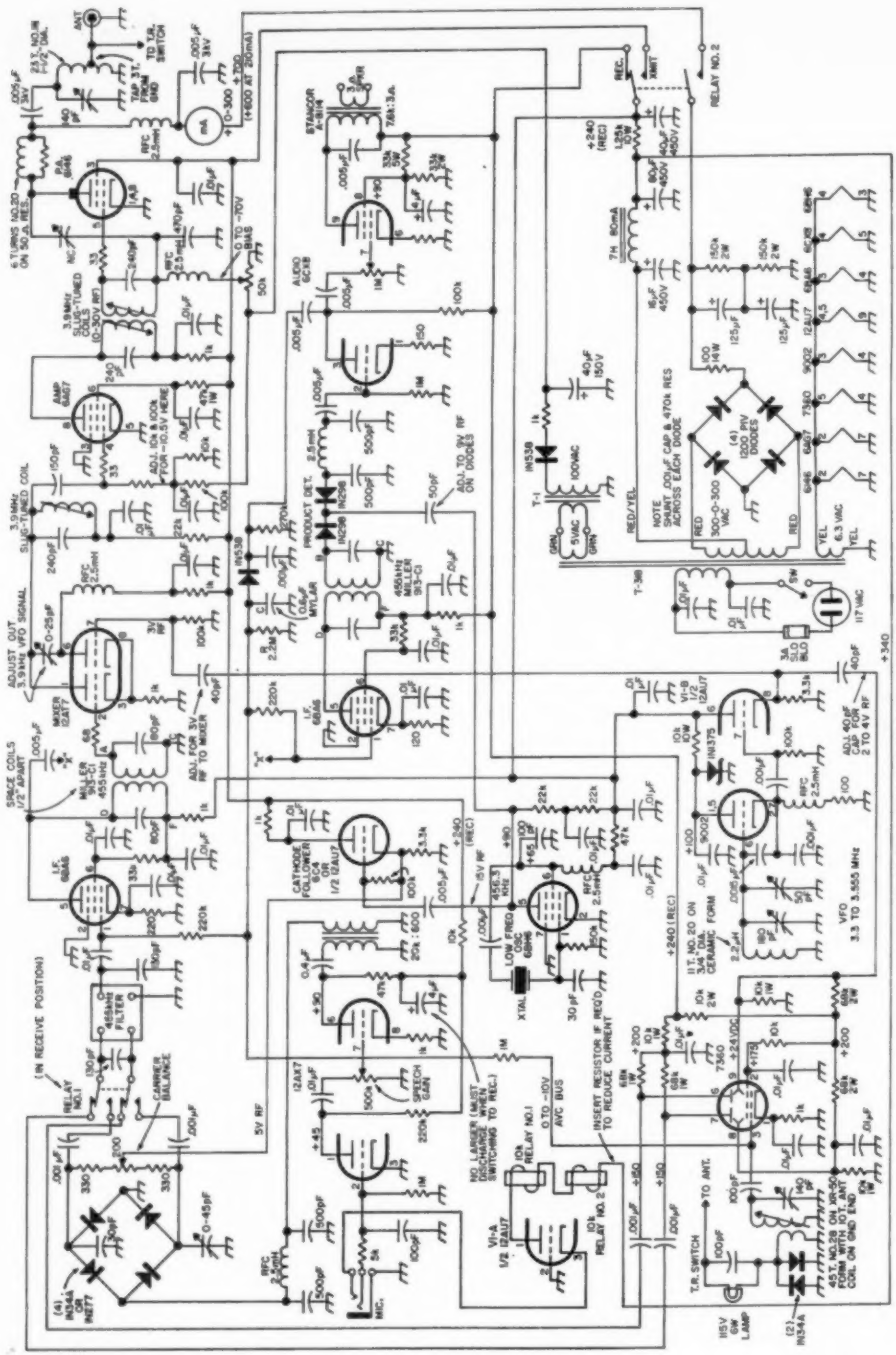

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I.F. 6BA6
1N538
CATHODE FOLLOWER 6C4 OR 1/2 12AU7
+240 (REC)
15V RF
456.3 kHz
LOW FREQ. OSC 6BH6
XTAL
30 pF
12AX7
SPEECH GAIN
20k:600
MIC.
RFC 2.5mH
NO LARGER (MUST DISCHARGE WHEN SWITCHING TO REC.)
0 TO -10V AVC BUS
INSERT RESISTOR IF REQ'D TO REDUCE CURRENT
V1-A 1/2 12AU7
10k RELAY NO.1
10k RELAY NO.2
+150
T.R. SWITCH
TO ANT.
115V 6W LAMP
(2) 1N34A
45 T. NO.28 ON XR-50 FORM WITH 10 T. ANT COIL ON GND END
7360
+24VDC
+175
+200
+240 (REC)
11T. NO.20 ON 3/4" DIA. CERAMIC FORM
2.2µH
VFO 3.3 TO 3.555 MHz
9002
1N375
V1-B 1/2 12AU7
ADJ. 40pF CAP FOR 2 TO 4V RF
+340
NOTE-ALL VOLTAGES MEASURED WITH HEATHKIT VTVM
REC.
XMIT
RELAY NO.2
+240 (REC)
1.25k 10W
7H 80mA
T-1
100VAC
5VAC
40µF 150V
RED/YEL
NOTE SHUNT .001µF CAP & 470k RES ACROSS EACH DIODE
(4) 1200 PIV DIODES
300-0-300 VAC
6.3 VAC
T-38
SW
117 VAC
3A SLO BLO
6146
6AG7
7360
9002
12AU7
6BA6
6CX8
6BH6

Fig. 2. (Opposite page). Schematic of El Marrinero. A .01µF capacitor between the 200Ω carrier balance pot and the cathode follower.

because both signals could not be taken from the same point because of the by-passing effect of the .01 µF in the ring modulator. It just shunted the signal on the detector to too weak an output. The solution of taking the product detector from the oscillator plate and varying the coupling capacitor (50 pF) value to the product detector, a 6-9 volt rf signal could be set. The 100 kΩ resistor on the grid of the cathode follower does not load the oscillator down and the signal for the modulator can now be taken off from the 3.3 kΩ cathode resistor which is now a low impedance point. This better matches the diode modulator and we have 5 volts here to apply to the arm of the balance potentiometer.

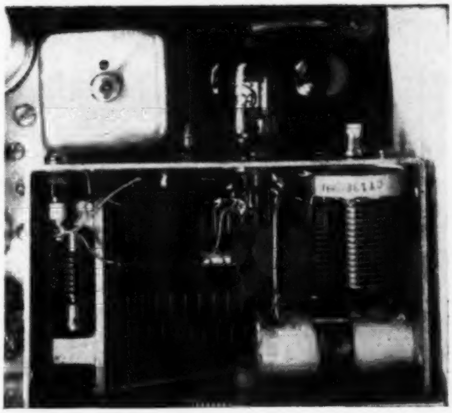
While we are talking about the ring modulator it could be mentioned some of the early photographs of the rig showed the balance pot above the chassis on a bracket. It was later moved to a panel control, which in conjunction with a pF trimmer capacitor nulls out the carrier. The pF balances out the fixed 30 pF added on the other side of the modulator to obtain a greater null. This is necessary because the pot has a metal cover and being bolted to the chassis has unbalanced capacitance. It was found un-necessary to use the extra capacitors if the pot was insulated from the chassis.

The vfo

Because of the high value of shunting capacitance across a small inductance this oscillator is mechanically and frequency stable. To me it is amazing having built many type of oscillators that seemed to drift forever. Theory is probably un-necessary since the 180 pF variable capacitor from the ARC-5 transmitter padded with a 50 pF APC type capacitor, and 12 turns of #20 en. wire wound on a ¾ inch ceramic form just tunes the 3.75 to 4.0 MHz amateur phone band. The oscillator itself of course is tuning 3345 to 3555 kHz.

A cathode follower was used after the VFO to prevent any pulling effect on the oscillator which might or might not occur. If the VFO was just used in a receiver the follower would not be needed. It might seem strange that a 9002 tube was used for the oscillator in place of the 6C4. Either one will work, but the 9002 is smaller and could be fitted between the box and transformer with no room to spare.

No measurements have been made on the oscillator stability, but from a cold start it does not drift off from a SSB signal. It has been used in several receivers with excellent results without any temperature compensating.



VFO box. Note the coil wound on the ceramic form.

Receiver

Pages have been writen in QST on the merits of using the 7360 tubes as a front end and mixer because of its low inter-modulation. We used it to do away with an rf stage. It was found the grid coil should be an air wound large coil if possible for the best selectivity. The 4.5 MHz sound *if* cans were tried and found too broad. Because of room restrictions a compromise was used by winding 28 turns of #28 wire on a XR-50 coil form with ten turns on the bottom for the antenna. It works half way between the two other coils and is satisfactory. During the experiments with this tube several rules must be followed, the supply must be set at 200 volts by adjusting the 10 kΩ 2 watt value of resistor. Otherwise the 1200 ohm cathode resistor value might have to be changed. In some instances the plate load resistors have to be lowered to 27 kΩ and the cathode resistor varied for best output mixed signal if a lot of output is desired. The cathode value can go as low as 600 ohms. When building this mixer observe that the accellerator has 175 volts on it, the two plates 150 volts and 2 to 4 volts of rf from the VFO to swing the beam. If these tolerances are held there should be no problem. AVC can be put on the tube after the receiver is finished and for preliminary adjustment the AVC bus can be taken off and the 100 pF coupling capacitor left out if desired. There seems to be some advantage in using AVC on this tube where strong local signals are heard.

The signal from the 7360 mixer is fed into the mechanical filter which is tuned by a 130 pF capacitor. Whether this value applies to all

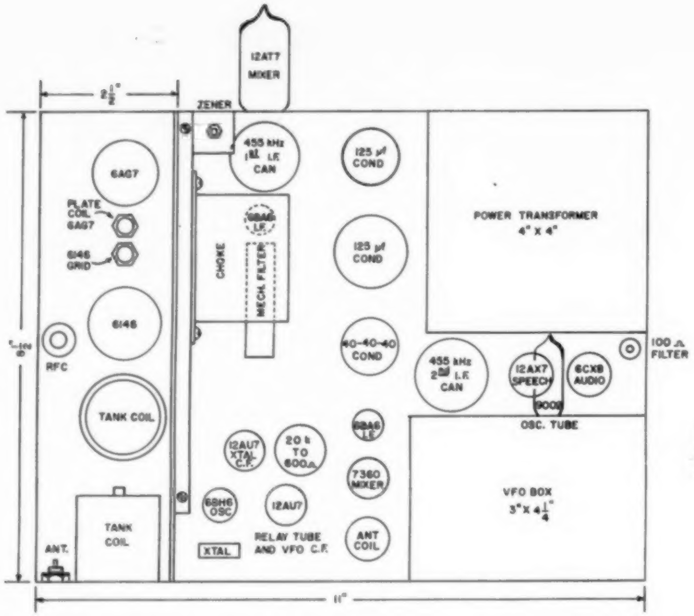
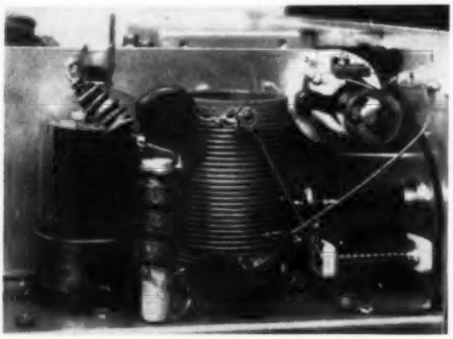

12AT7 MIXER
2 1/2"
ZENER
455 kHz 1st I.F. CAN
125 µf COND
6AG7
PLATE COIL 6AG7
6146 GRID
CHOKE
6BA6 I.F.
MECH. FILTER
125 µf COND
POWER TRANSFORMER 4" x 4"
6146
8 1/16"
RFC
40-40-40 COND
455 kHz 2nd I.F. CAN
12AX7 SPEECH
6CX8 AUDIO
100 Ω FILTER
9002
OSC. TUBE
TANK COIL
6BA6 I.F.
12AU7 XTAL C.F.
20 k TO 600 Ω
7360 MIXER
VFO BOX 3" x 4 1/4"
6BH6 OSC
12AU7
TANK COIL
ANT COIL
RELAY TUBE AND VFO C.F.
XTAL
ANT.
11"

Fig. 3. Layout of El Marrinero as built by Ed Marriner W6BLZ.

Collins filters is unknown but should be very close to a practical value. This one was found by putting a variable capacitor across the filter and tuning it for resonance and measuring the value.

If stages 455 kHz

When the signal comes out of the filter it goes into a 6BA6 *if* stage. Here is where most constructors run into trouble trying to prevent the stage from oscillating. In anticipation the cathode resistor was increased from its normal value of 68 ohms to 120 or 220 ohms and it is suggested that the new J. W. Miller 913-C.T. transformers be used. The grid tap on these has been placed one-third of the way down from the top of the coil to lower the grid impedance. You will notice that the coupling to the second *if* is taken off from the primary of the first *if* transformer by a .005 µF capacitor. Smile if you will, but it serves two purposes, it allows the mixer grid to return to ground and it gives more gain plus it stops oscillations. This coil incidentally was modified by squeezing the coils to within one-half inch of each other. This can be tricky but by scraping the glue from the rod and inserting a spacer one-half inch thick the coil can be pushed up against it by taking a piece of wood and drill a half inch hole in it and slipping it over the rod. If this is not done the pi will push out or the coils will two-block and won't come apart. (voice of experience!) It is necessary to push the coils together to obtain enough coupling to the 12AT7 mixer grid. The coupling from the primary to the second *if* does not effect the selectivity because we are using a mechanical filter.



Final amplifier, tank coil and TR switch.

Since the placement of the coils in this transceiver layout were six inches apart a piece of RG-174 was used to bring the signal from the .005 to the grid of the second *if* tube. This extra capacitance was too much for the 100 pF tuning the first *if* can and 80 pF had to be put inside the can in place of the 100 pF. The second *if* can tuned without modification.

Product detector

This product detector is becoming very

SPACE PACKAGE

SBE SB-34 . . . advanced space age circuits. Small size solves space problems at home or mobile . . . only **$395 (12V DC & 117V AC built-in power supply).** Write for complete brochure.

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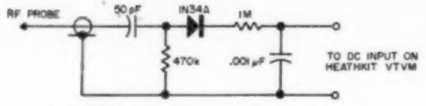

THIS CAN BE BUILT INTO A METAL TUBE SHIELD, USING A 9-PIN SOCKET

Fig. 4. RF probe for tuning up El Marrinero.

popular as it saves a tube. Just don't use silicon diodes or it won't work, there has to be internal leakage. The original circuit used IN67's but 1N298's and 1N38's have been used. The RFC keeps the rf from getting into the audio which might cause hissing. A 47 kΩ resistor works just about as well as the RFC.

This completes the receiver. To align it it would be nice to have a signal generator or a 455 kHz crystal, however, if you don't just tune in an 80 meter signal and peak the *if* cans for maximum output. Remember to ground the AVC bus before tuning.

The rectified audio used for the AVC will go up to 15 volts on loud signals. The length of time it holds up can be varied by changing the value of the 2.2 MΩ resistor and the 0.6 µF Mylar or low loss capacitor. The hold-up time can be watched on a VTVM voltmeter.

With an rf probe make sure that at the junction of the two diodes of the product detector have 6 to 9 volts. If there is not enough voltage such as 2 volts, the signals will sound distorted or not mixing. This can be very apparent if you just pull the crystal out if you care to see what it sounds like with no injection.

It might be mentioned that the screen of the 6CX8 must be by-passed with a heavy capacitor such as the 4 µF to obtain increased gain. With this by pass no capacitor is necessary on the cathode. The screen voltage is held constant by the 33 kΩ resistor voltage divider, making this tube different from using a 6AQ5 where it is not necessary.

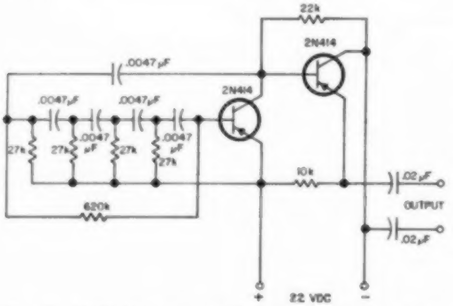

Fig. 5. 1200-Hz tone oscillator for inserting a signal into the microphone jack to produce a signal for tuning. Construction isn't critical.

Confidentially this is a pretty good receiver, simple and easy to build except for taming oscillations in the *if*'s.

Test equipment

There is no limit on the amount of test equipment that could be used when building SSB equipment. Many look with awe or askance when I say this rig was built with just a grid-dip meter, Heathkit VTVM and an rf probe and a borrowed RCA signal generator which had a variable output so that initial voltage injections could be found. A similar rig was built without the generator and only a 200-500 kHz receiver used to listen to the signal at 455 kHz before it was mixed. Most of the SSB trouble come from mixing or oscillations in the 3.8 to 4.0 MHz region of the driver or final amplifier tubes. A receiver in the 3-40 MHz frequency range would naturally be helpful listening to the VFO and the final signal but you could get by with just a GDO. Once the 80 meter signals are picked up you can use them to test and align the rig. The test gear ranges then from nothing to as much as you can lay your hands on. The more you fuss with building the gear, the less test equipment you need and more ways can be found to improvise for any particular adjustment. I find a calibrated capacitor handy when trying to find out what value of fixed capacitor to put across a coil. A GDO is handy for finding a coil's resonance. A field strength meter is handy to balance out the carrier, or when tuning up into a dummy load. The old "Q" fiver tuning 200 to 500 kHz is nice to listen for the first squeek of life out of the 6BA6 *if* amplifier. At least you know you are SSB on 455 kHz. An rf probe is a necessity; see **Fig. 4.**

Transmitter portion

Here we are at the transmitter portion. When we are through with this article you have had a course in SSB transciever construction.

Many circuits were tried before ending up with this present configuration. Each time the rig was finished something new appeared to cause circuit changes. Originally a 7360 was used for the balanced modulator. It seemed to work fine most of the time, however, every once in a while carrier would appear. The trouble was traced to changing accelerator voltage, which caused upbalancing of the carrier. The tube being in the field of the choke also caused carrier unbalance as the field around the tube changed. The circuit was changed to the more stable diode ring modulator.

The circuit has been described up to the 12AT7 mixer where we squished the *if* coil together to drive the grid of the mixer. The VFO signal was picked up by a field strength meter in the mixer output coil. The small capacitor between its plates was varied until the signal from the VFO was reduced and the coil tuned up by feeding a tone into the audio input of the transmitter. The output of the mixer should be about 5 volts of rf to drive the 6AG7 which builds the signal up to 30 volts of rf sufficient to drive the 6146 in AB-1. A shield box was put around the 6AG7 socket and a shield across between the grid and plate pins to prevent oscillation. The signal was carried to the 6AG7 grid by RG-174 coax. The output signal to the 6146 grid comes through the box by a feed-through insulator. Using this shielding technique the 6146 did not need neutralizing. Since the grid circuit of the 6146 is tuned and coupled to the tank coil of the 6AG7 inductively to prevent VFO feed-through, it is prone to self-oscillation unless extreme shielding is used. If tuning capacitors and large coils are used they should be put in a box. For AB-1 operation the 6146 needs about 50 volts of bias. The 6AG7 bias is adjusted for −10.5 volts so that the cathode can be grounded. This tends to make a more stable driver tube arrangement.

Tuning of the transmitter can be accomplished by inserting an audio tone into the microphone input (See **Fig. 5** for a generator) or by unbalancing the carrier control knob slightly.

If you'd like to include VOX, the circuit for it is shown in **Fig. 6**.

Well, thats it, I'm proud of my little rig that goes with me on vacation trips. Despite the struggle getting all of the bugs out of it I had fun finding out for myself how the various SSB circuits work rather than just reading the book. I'm sure there are many improvements that could be made but the rig sounds first class, and that is what counts.

. . . W6BLZ

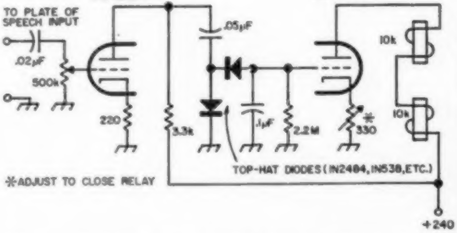

Fig. 6. Optional VOX circuit for El Marrinero.

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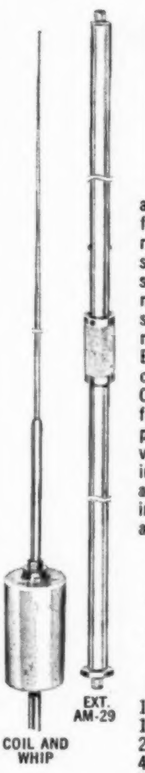
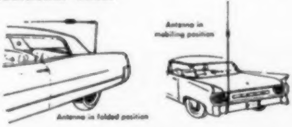


New 36" and 48" Stainless Steel Laydown Extension used in conjunction with miniaturized coils, capable of handling 500 Watts AM. Adjustable one-piece whip and coil moves in and out of resonant frequency. Coils are 2⅛" in dia., lengths range from 2" to 7" depending on desired band operation. Antenna coils designed specifically to handle high power mobile operation while utilizing the small streamlined antenna design normally desired for low powered mobiles. Extension lays over at 18". Extension, coil and whip maximum height 82". Constructed of stainless steel with brass fittings, corrosion resistant, weatherproof. Slim locking sleeve holds a rigid vertical position, extremely convenient in clearing garage doors, car ports and low overhangs. Extension terminates in a ⅜"-24 stud at both ends for additional uses.



BANDWIDTH RESONANT FREQUENCY

10 Meters — Approx. 100 to 120 KC
15 Meters — Approx. 100 to 120 KC
20 Meters — Approx. 80 to 100 KC
40 Meters — Approx. 40 to 50 KC
75 Meters — Approx. 25 to 30 KC

POWER RATING: AM-dc input, 250 Watts - SSB-dc input 500 Watts

AM-29	36" Stain. Steel Laydown Ext. Breaks at 18" (Fender or Deck Mt.)	$11.95
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AM-30	80 Meter Coil & Whip	9.95
AM-31	40 Meter Coil & Whip	8.95
AM-32	20 Meter Coil & Whip	7.95
AM-33	15 Meter Coil & Whip	6.95
AM-34	10 Meter Coil & Whip	5.95

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Two Tubes for Two

Get on two meter sideband with only two tubes (and a 20-meter SSB transmitter, of course).

With the increase in activity and the tremendous amount of nightly QRM on the lower frequency bands, we are all forced to move up in the spectrum in order to enjoy our operations. Until now, most of the transmitting converters to allow lower frequency SSB units be used on VHF have been so complicated, that the converter costs more than the SSB generator! Here's a unit that will let any 20 meter SSB transmitter be used on two meters with a minimum of materials, time, and labor. The end result is most satisfying and will give you hours of pleasure without that darn QRM and lower frequency squabble!

The "Two for Two" consists of a simple 6EA8 oscillator generating 43.333 MHz in the triode section and multiplying that up to 130 MHz which is fed into the cathode of the 6360 mixer. A 14 MHz signal from the exciter is fed into the grids of the 6360 with a prewound 20 meter coil. This makes a very easy coil-winding job to construct the Two for Two. The coupling link in the coil can be moved to allow proper coupling for the amount of injection needed to drive the 6360 mixer-final.

The power supply can be built on a separate chassis, or on the back of the converter chassis, depending on the method and space of using the Two for Two. The reason for this is that you just may have room in your existing lower frequency transmitter to allow the mounting of the Two for Two on the back panel or on a lip inside the top cover. The power supply would then be remote. In any event the power supply is very simple. I used an old discarded television transformer and designed the supply to give me all of the voltages needed, including that always troublesome bias voltage. So many of the bias voltages in equipment built today have the battery supplies that always cause trouble with dead batteries and consequent loss of tubes. This one is a very simple, but yet tremendously effective supply that allows complete cut-off of the final during the receive periods via S1.

Construction of the unit is very simple and straightforward. The only item to watch during construction and layout is that you mount the 20 meter B & W input coil, L3 on top of the chassis and the final amplifier coil, L4 underneath in order to allow complete shielding between the input and output sections. This also allows for the output meter to be mounted on the front lip of the chassis along with the plate and load controls of the final. The grid capacitor, C1 is mounted on the back portion of the chassis with the shaft extending through the bottom of the chassis. This control need only be set once and forgotten, as any peaking of this section can be done with the exciter. If you desire to mount the converter in your present transmitter, merely build the rf section. This will make a small strip of chassis to mount inside the cabinet. The power supply is built on a separate chassis and remoted. S1, the bias control, is most convenient as part of the antenna coaxial relay. This can be wired to work with your SSB transmitter therefore making complete control of the two meter station just as it is on 20 meters, VOX and all!

The crystal socket can be mounted by soldering the pins of the socket directly to pin nine of the 6AE8 and a ground lug. L1 is mounted as close as possible to pin one as L2 is to pin six. This allows for the link from L2 to lay close to pin two of V2, 6360. Both rotor sections of C1 are connected directly to the coil, L3, all above the chassis. Two small grommets are mounted at each end of L3 in the top of the chassis and the 10 ohm resistors are wired from pins one and three up through the chassis to L3. The two 470 ohm resistors are mounted directly on the coil form, L3, as the bias center tap is fed through another small grommet to the power supply station. C2 is

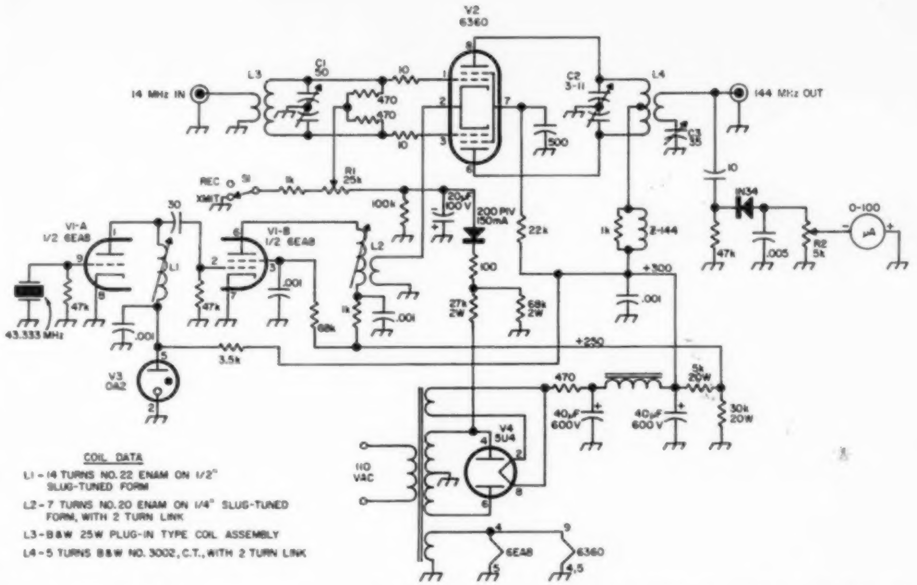

V2
6360
14 MHz IN
L3
C1
50
10
470
470
10
C2
3-11
L4
C3
35
144 MHz OUT
500
REC
S1
XMIT
1k
R1
25k
100k
20µF
100V
200 PIV
150mA
22k
1k
Z-144
10
1N34
0-100
µA
47k
.005
R2
5k
+300
V1-A
1/2 6EA8
30
V1-B
1/2 6EA8
L1
L2
47k
47k
.001
.001
.001
68k
1k
.001
100
27k
2W
68k
2W
.001
43.333 MHz
.001
3.5k
+250
V3
OA2
470
5k
20W
40µF
600V
40µF
600V
30k
20W
V4
5U4
110
VAC
6EA8
6360
COIL DATA
L1 - 14 TURNS NO. 22 ENAM ON 1/2" SLUG-TUNED FORM
L2 - 7 TURNS NO. 20 ENAM ON 1/4" SLUG-TUNED FORM, WITH 2 TURN LINK
L3 - B&W 25W PLUG-IN TYPE COIL ASSEMBLY
L4 - 5 TURNS B&W NO. 3002, C.T., WITH 2 TURN LINK

Fig. 1. K9EID's Two for Two two meter sideband mixer. This simple circuit converts 20 meter sideband energy to 144 MHz. It can be used alone for a few watts of SSB, or with an amplifier.

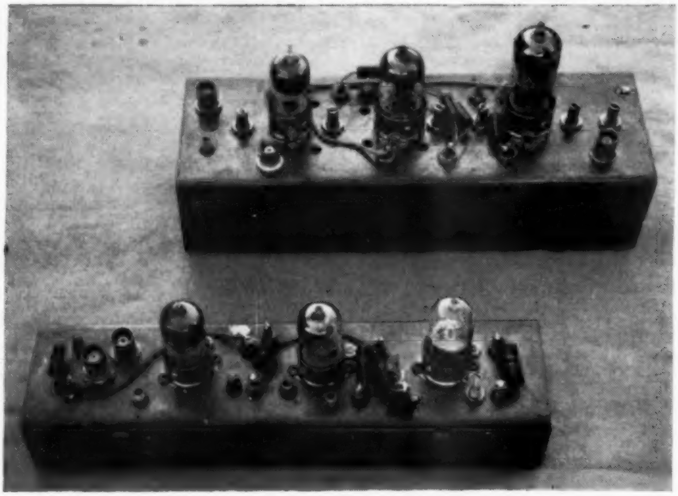
mounted on the front panel so that the stator sections can actually slip right into the pins six and eight of the 6360 tube socket. Solder these connections and then solder the coil form, L4 directly to the pins six and eight, also. C3 is mounted directly to the right of C2. All of the rf output meter components are mounted on the front panel. Be certain to observe the shunted resistor across the rf choke in the plate lead of the 6360. This is installed to prevent any self-oscillation of the rf choke and the final capacitor.

Upon completion of the construction, which should take only one good evening of your time, begin tune-up by first measuring the plate leads with all power off with a VTVM to check for any shorts or misconnections. After this is determined, apply filament voltage and wait for warm up. First measure the bias voltage at pin one or three of the 6360. S1 should be open, or in the receive position. The voltage here should read around −50 volts. Close S1 and while continuing to read this bias voltage, adjust R1 so that the bias reads about −22 volts. Now observe the color of the 6360 plates. They should not be red. If they are, adjust R1 until they show no trace of color; further checking will likely reveal that the plate and screen voltages are too high as a result of differences in the power supply components. Adjust the resistances so that the plate of the 6360 reads +280 to 300 volts and the screen +160 to 180 volts.

At this time it will be necessary to begin checking the oscillator with the grid dipper for output. Adjust L1 for maximum 43.333 MHz energy. Then adjust L2 for maximum 130 MHz energy. While using the dipper, adjust L4 and C2 to resonate at 144 MHz. Now apply 20 meter energy from the exciter and tune the plate and load control of the exciter. Adjust C1 for maximum grid drive to the 6360. The last adjustment will be to adjust the plate and load of the 6360 to your antenna system and set R2, meter shunt for mid scale reading with full carrier injected from the exciter. Don't forget that S1 must be in the transmit position in order to have any energy pass through the mixer and final of the Two for Two. The tube is completely cut off in the receiver mode.

This should complete your unit. A linear amplifier can be added for higher power, but is not needed for most two meter SSB communications. This unit runs a few watts PEP. With a fairly decent antenna system this signal can have the effectiveness of much higher power and will do quite nicely for those nightly contacts without all the muss and fuss, though you may need an amplifier with more tuned circuits if you have any TVI. Have fun!

. . . K9EID/8



Top view of the 432 MHz mixer (top) and local injection generator.

Del Crowell K6RIL
1674 Morgan Street
Mountain View, Cal.
Photos: Ken Hetchler

A Practical 432 MHz Transmitting Converter

This easy-to-build and not-too-expensive converter will put your 10 meter SSB, AM or CW transmitter on 70 cm.

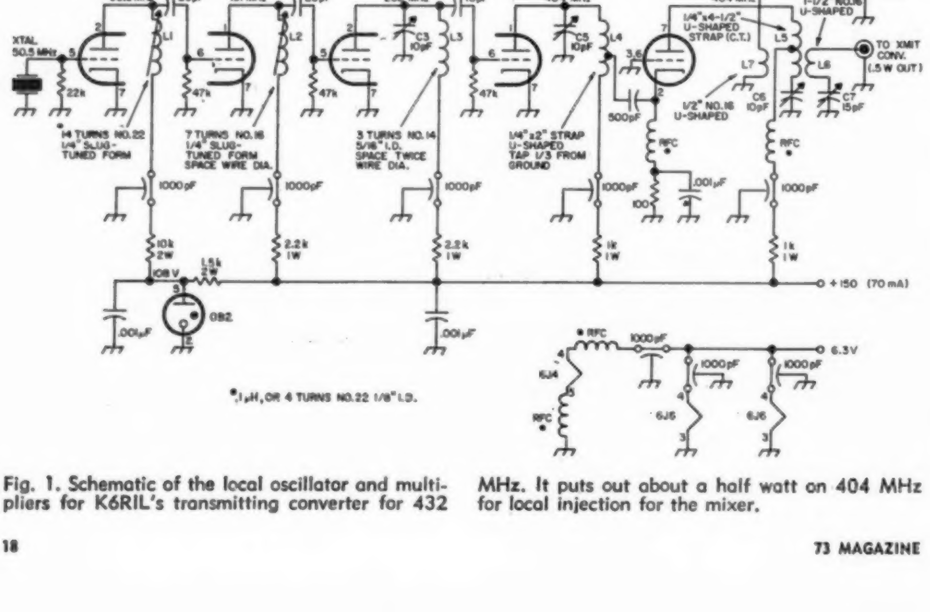

6J6
6J6
6J4
XTAL 50.5 MHz
50.5 MHz
20pF
101 MHz
20pF
202 MHz
10pF
404 MHz
404 MHz
22k
47k
47k
47k
L1
L2
C3 10pF
L3
C5 10pF
L4
L5
L6
L7
C6 10pF
C7 15pF
3.6
500pF
*14 TURNS NO.22 1/4" SLUG-TUNED FORM
7 TURNS NO.16 1/4" SLUG-TUNED FORM SPACE WIRE DIA.
3 TURNS NO.14 5/16" I.D. SPACE TWICE WIRE DIA.
1/4"x2" STRAP U-SHAPED TAP 1/3 FROM GROUND
1/4"x4-1/2" U-SHAPED STRAP (C.T.)
1/2" NO.16 U-SHAPED
1-1/2" NO.16 U-SHAPED
TO REC CONV.
TO XMIT CONV. (.5 W OUT)
RFC
RFC
1000pF
1000pF
1000pF
1000pF
1000pF
.001µF
100
10k 2W
2.2k 1W
2.2k 1W
1k 1W
1k 1W
1.5k 2W
108 V
OB2
.001µF
.001µF
+150 (70 mA)
RFC
1000pF
6.3V
1000pF
1000pF
6J4
RFC
6J6
6J6
*1µH, OR 4 TURNS NO.22 1/8" I.D.

Fig. 1. Schematic of the local oscillator and multipliers for K6RIL's transmitting converter for 432 MHz. It puts out about a half watt on 404 MHz for local injection for the mixer.

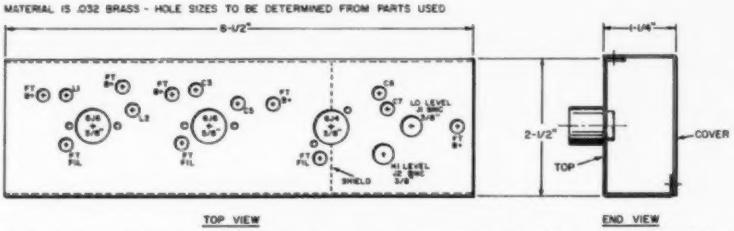


Fig. 2. Layout and construction of the local oscillator-multiplier shown in Fig. 1. ⅓ size.

Like to get on 432 MHz? Activity on the band is increasing every day, and the converter described in this article makes it possible for many hams to increase their frequency coverage and modes of transmission. This transmitting converter can be built at reasonable cost for operation on 432 MHz using CW, SSB, or AM. This is a linear system which reproduces the type of signal that is fed into it. The input frequency of 28 MHz was picked to reduce spurious signals and be compatible with most 10 meter transmitters. It will work with simple transmitters designed for only CW and AM, or with more elaborate units that cover all modes of transmission. The construction follows in two parts. The transmitting converter and local oscillator chain are built as separate units to allow versatility, and for easier installation into chassis with higher power amplifiers.

Local oscillator chain

This oscillator and multiplier chain shown in **Figs. 1** and **2** uses inexpensive tubes. It starts with one half of a 6J6 as a 50.5 MHz oscillator. It operates at low plate voltage with an 0B2 regulator for frequency stability. The three frequency doublers are nearly identical with exception of the tank circuits.

Last in the chain is a 6J4 grounded grid amplifier which delivers .5 watt at 404 MHz. This chain requires plus 150 V but can be used with plus 200 V and the output power will be approximately 1 watt. Good construction practice must be used as in most UHF circuits: direct connections, shielding, short leads, good bypassing, etc.

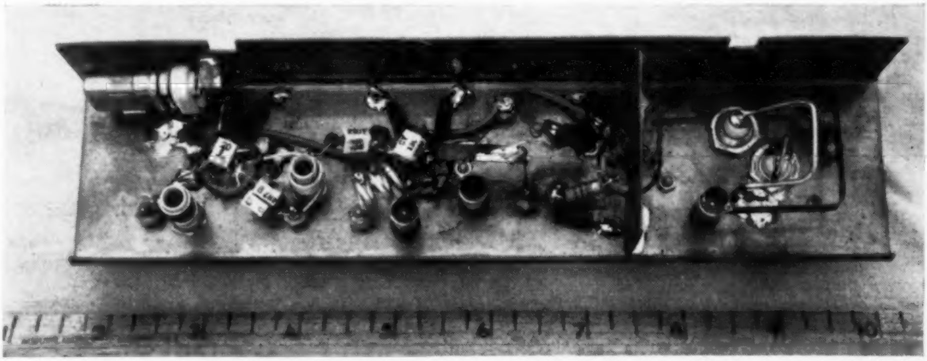
By building the oscillator and multiplier on a separate chassis the builder can use it for other experimental work. The unit is fixed frequency. It can be mounted in any position as it doesn't require constant adjustment.

Variable capacitors used are JFD but any good quality piston capacitor can be substituted. The largest expense is feed-through capacitors. These can be any coaxial type, threaded or solder-in, which are used in TV UHF tuners. These are easily broken, so use care in soldering them.

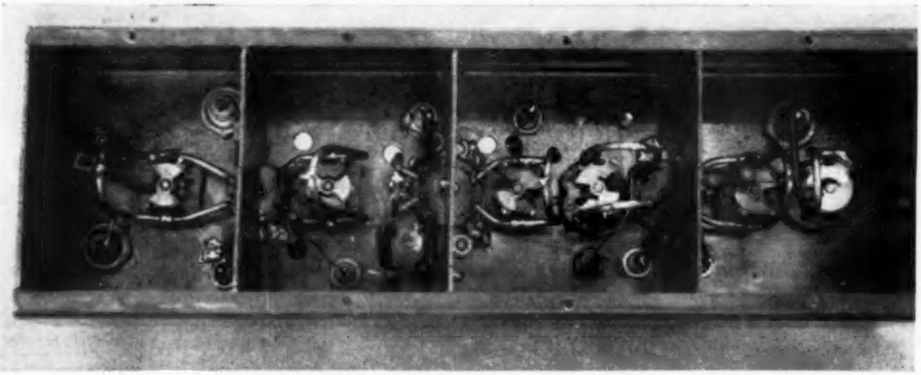
Since the local oscillator chain will be needed for adjusting the transmitting converter I recommend that you build it first.

The transmitting converter

The converter is shown in **Figs. 3** and **4.** The balanced mixer uses a 6J6 with the 404 MHz



Local oscillator and multipliers shown in Figs. 1 and 2. The crystal is at left and output is at the right. Notice that two output links are shown. The larger is for the transmitting converter and the smaller is for the receiving converter. The chassis is made of brass.



432 MHz transmitting converter. The left compartment is the input from the local oscillator and the 28 MHz exciter. The two center compartments are mixer plate and driver grid and driver plate and final grid. The output connector for about 5 watts at 432 MHz is at right.

local oscillator signal injected at the grids and up to 1 watt of 28 MHz signal injected into the cathode.

The driver stage uses a type 5656 tube operating class A with -3 to -4 volts fixed bias. This tube has an internal screen bypass capacitor of 15 pF and doesn't require external bypassing. The circuit is push-pull delivering about 2 watts at 432 MHz. This tube was built by Raytheon for use as class A and C amplifiers in UHF equipment for military and commercial aircraft. It is available through MARS or surplus outlets. Specifications can be found in ARRL Handbooks prior to 1955. The circuit could be rewired for a 6939 driver with good results.

A 6939 in the output stage does a fine job as a linear amplifier operating class AB2 with fixed bias of -6 to -8 volts. Plate current varies from 35 mA with no signal to 90 mA with full drive. It will deliver up to 5 watts output. All stages in the transmitting converter are operated as push-pull circuits. The tank coils are balanced quarter waves with the ex-

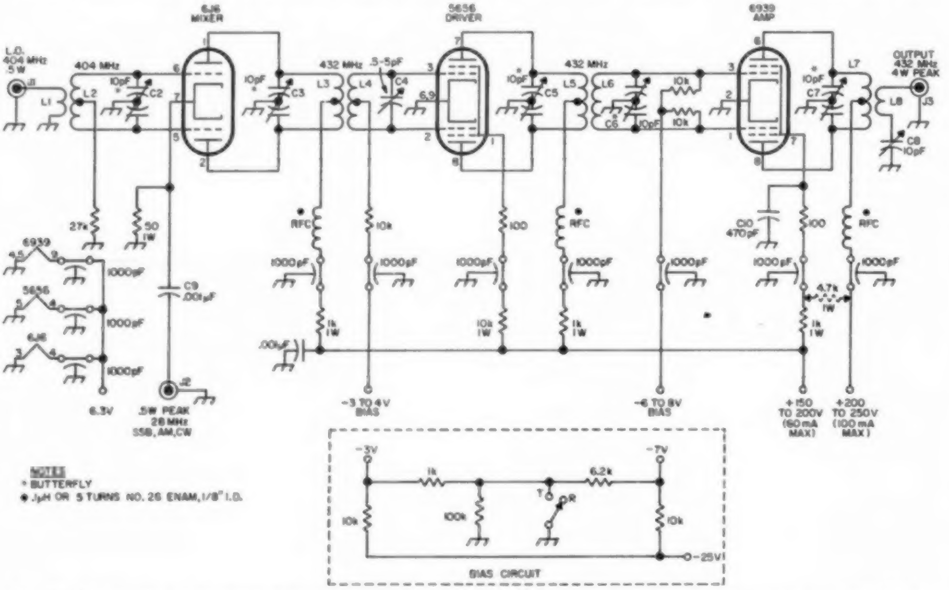
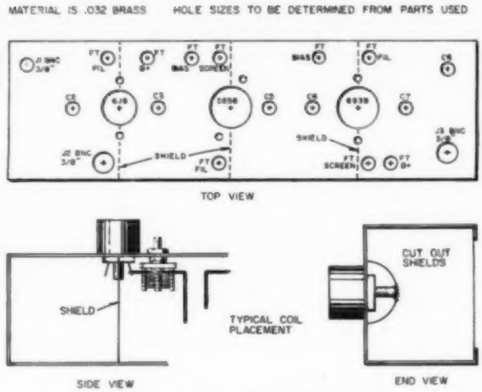

6J6
MIXER
5656
DRIVER
6939
AMP
L.O.
404 MHz
.5 W
J1
404 MHz
L1
L2
10pF
*
C2
10pF
*
C3
432 MHz
L3
L4
.5-5pF
C4
6,9
3
2
7
6
1
5
8
10pF
C5
432 MHz
L5
L6
C6
10pF
10k
10k
L7
C7
OUTPUT
432 MHz
4W PEAK
J3
L8
C8
10pF
27k
50
1W
6939
4,5
9
5656
5
4
6J6
3
4
1000pF
1000pF
1000pF
6.3V
C9
.001μF
J2
.5W PEAK
28 MHz
SSB, AM, CW
RFC
1000pF
1k
1W
.001μF
10k
100
10k
1W
-3 TO 4V
BIAS
-6 TO 8V
BIAS
C10
470pF
4.7k
1W
+150
TO 200V
(60 mA
MAX)
+200
TO 250V
(100 mA
MAX)
NOTES
* BUTTERFLY
● .1μH OR 5 TURNS NO. 26 ENAM, 1/8" I.D.
-3V
-7V
1k
6.2k
T
R
100k
-25V
BIAS CIRCUIT

Fig. 3. Schematic of the mixer and linear amplifiers for K6RIL's transmitting converter. L6 should be shown as series-tuned half-wave lines with C6 at the end. See the photograph at the top of the page.



ALL COILS MADE WITH NO. 14 OR 16 TINNED OR SILVER WIRE

BEND INTO SHAPES SHOWN AT RIGHT

COIL	A	B	C
L1	3/4"	1/4"	1/2"
L2	1"	3/4"	9/16"
L3	1-1/4"	1"	9/16"
L4	3/4"	1/4"	1/2"
L5	1"	3/4"	9/16"
L6	1-3/4"		9/16"
L7	3/4"	1/4"	1/2"

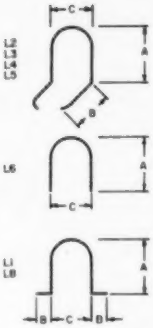


Fig. 4. Layout, construction and coil data for the transmitting mixer shown in Fig. 3. ⅓ size.

ception of the 6939 grid which uses half wave lines because of the high input capacitance. A quarter wave circuit would be too short to allow proper coupling. All lines are bent into a hair-pin shape. Most are bent at an angle as shown to conserve space and allow coupling between stages.

The butterfly capacitors used are Johnson 160-104 (9M11) and the tank is soldered along each side.

Construction

Shields are used across tube sockets for isolation and stability. The chassis parts were made from .035 inch brass, bent to form the shape required. Other shapes and styles may be used but the constructor must keep in mind that shielding and short lengths are necessary for good performance. All voltages are applied to tubes by feed-through capacitors and the dc circuitry is outside the chassis. Grounded tube pins are soldered directly to the chassis and shields are also soldered across the sockets. Brass gives the builder an opportunity to solder parts directly to the chassis as well as to conduct heat from tubes.

Adjustment and operation

After construction is completed, check for errors (wiring and assembly). A grid dip meter should be used to adjust the tuned circuits to frequency.

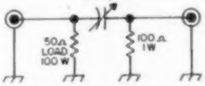
Next the dc voltages and local oscillator injection can be applied. Don't forget the bias for the tubes first. The transmitting converter current drain should be under 70 mA total with no 28 MHz drive. Feed in 28 MHz energy and adjust all the tank circuits for peak output at 432 MHz. Coupling is adjusted by bending the lines for maximum output and at the same time decreasing the 28 MHz level. After the circuits are all peaked, the output power should be greater than 4 watts with full 28 MHz drive. Both the 5656 and 6939 should indicate grid current. With the output connected to an antenna through a relay, and a receiving converter on, a small amount of noise will be noticed from the tubes which can be eliminated by switching the bias voltage to -22 volts for standby as shown in circuit diagram. This changes the bias voltage to cut both tubes off during standby and can be done by a pair of contacts on the antenna relay.

The exciter output power must be reduced to approximately .5 to 1 watt for driving the mixer input. There are many ways to accomplish this. **Fig. 5** shows the most common method.

This converter was constructed to allow mounting which will have provision for tuning from a front panel. I notice much of the equipment in magazines is without front panel controls. I prefer controls on all the equipment used at this station, as this makes for more flexible operation and everything can be located in racks.

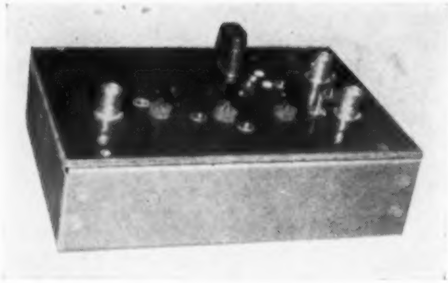
Good luck. See you on 432 side band.

. . . K6RIL



50Ω LOAD MAY BE ANY DUMMY LOAD WHICH WILL DISSIPATE POWER FROM TRANSMITTER USED. THE HEATH CANTENNA WORKS VERY WELL.

Fig. 5. Pad for reducing the power from a 28 MHz transmitter to about 1 W.



Robert Friess K6HMO
2434 Rock Street #10
Mountain View, California

A Low-Cost FET Two Meter Converter

This converter uses inexpensive field effect transistors as mixer rf amplifiers. It has a noise figure of less than 2.5 dB and very low cross modulation.

In the last year or two several bipolar transistors (conventional junction transistors) have been introduced which provide excellent VHF characteristics. A low noise VHF converter using these devices will be lower in cost, provide better performance, and use simpler circuits than a vacuum tube converter. Bipolar transistors costing only a dollar or two will produce noise figures as low as dB at 144 MHz. These devices share one serious shortcoming, however. They are very susceptible to cross modulation.

Cross modulation

One feature that all bipolar transistors and diodes have in common is a transfer function in which the current flow in a forward biased pn junction, e.g. the base-emitter junction of a transistor, is proportional to $e^{qv/kt}$, where q is the charge on an electron, k is Boltzmann's constant, v the applied voltage, and t the Absolute temperature. $e^{qv/kt}$ can be expanded into a series as

$$e^{qv/kt} = 1 + qv/kt + \frac{(qv/kt)^2}{2!} + \frac{(qv/kt)^3}{3!} + \dots$$

The even order terms produce harmonics, even order combination frequencies, and dc terms. These products are usually not troublesome. It is the odd order terms which cause cross modulation.

At room temperature, 290°A, kt/q is equal to 26 millivolts. For voltages v greater than 26 mV the exponent qv/kt has a value greater than unity, it can be seen that the third order term increases rapidly when qv/kt is greater than unity. If v is composed of two voltages $E_a \sin \omega_1 t + E_b \sin \omega_2 t$ a little algebra will show that there will be a component at ω_1 with amplitude proportional to E_b and a component at ω_2 with amplitude proportional to E_a. This causes cross modulation.

The action of the fifth and higher order odd terms is similar to that of the third order term.

Therefore, we can conclude that with bipolar semiconductors applied voltages around 26 mV. will result in serious cross modulation. It is important to note cross modulation can occur not only in the first stage of a receiver, but in any stage where two or more large amplitude signals are present.

The designer of a receiver front end is faced with a serious problem. A highly selective filter which would prevent all but one signal from reaching a transistor or diode will be a lossy device. In order to have a noise figure as low as possible it is desirable to precede this filter with enough gain to make its effect on noise figure negligible. However, this gain may result in the whole 2 meter band being amplified at once by 30 dB or more, and large voltages may easily result when strong signals

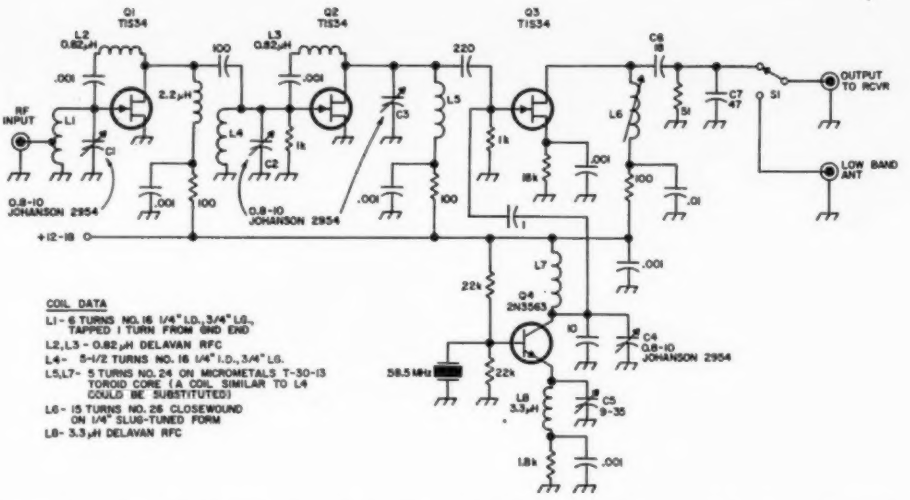

Q1
TIS34
L2
0.82μH
.001
RF
INPUT
L1
C1
0.8-10
JOHANSON 2954
2.2μH
100
.001
100
+12-18
L3
0.82μH
.001
L4
C2
1k
Q2
TIS34
C3
0.8-10
JOHANSON 2954
.001
100
L5
220
Q3
TIS34
1k
18k
.001
1
C6
18
L6
100
.01
51
C7
47
S1
OUTPUT
TO RCVR
LOW BAND
ANT
.001
22k
L7
Q4
2N3563
10
C4
0.8-10
JOHANSON 2954
58.5 MHz
22k
L8
3.3μH
C5
9-35
1.8k
.001
COIL DATA
L1 - 6 TURNS NO. 16 1/4" I.D., 3/4" LG., TAPPED 1 TURN FROM GND END
L2, L3 - 0.82μH DELAVAN RFC
L4 - 5-1/2 TURNS NO. 16 1/4" I.D., 3/4" LG.
L5, L7 - 5 TURNS NO. 24 ON MICROMETALS T-30-13 TOROID CORE (A COIL SIMILAR TO L4 COULD BE SUBSTITUTED)
L6 - 15 TURNS NO. 26 CLOSEWOUND ON 1/4" SLUG-TUNED FORM
L8 - 3.3μH DELAVAN RFC

Fig. 1. Schematic of K6HMO's low-noise, low-cross modulation two meter converter using inexpensive field effect transistors (FET's). This converter can give a noise figure of under 2.5 dB, gain of 27 dB and very good rejection of cross modulation products.

are present. Some readers may have had trouble with FM and TV stations showing up in their transistor converters or receivers. It is usually insufficient front end selectivity and resultant cross modulation which are responsible.

The FET at VHF

The field effect transistor has an almost perfect square-law transfer function, i.e. odd order terms are almost nonexistent. The result is greatly improved cross modulation performance. In addition, recently introduced FETs are capable of very low noise performance in the VHF and UHF range. Noise figures as good as any vacuum tube or bipolar transistor are readily obtainable.

The device selected for this converter, the TIS34, is made by Texas Instruments and is encased in an economy plastic package. The price is $2.80. The TIS34 is very similar to the 2N3823—it appears to be the same chip—which has been available for some time for about $12. The data sheet for the 2N3823 is much more complete than the one for the TIS34 and it was used in the design of this converter.

Construction

The FET converter shown in **Fig. 1** was constructed on a piece of printed circuit material cut 4x6 inches. The completed converter was mounted in an upside down 4x6x1½ inch aluminum.

The circuitry is very conventional and makes use of single-tuned transformers for impedance matching and to provide the required selectivity.

The noise figure test for the TIS34 specifies a source impedance of 1000 ohms. This is obtained with the tapped input inductor. The drain load impedance is simply the parallel combination of the real part of the FET input impedance and R1. The imaginary part of the input impedance is tuned out with L4 and C2. L2 is a standard rf choke used for neutralization by resonating with the drain-gate capacitance at 144 MHz. The second stage is essentially identical to the first. The rf amplifiers are simple, stable, and use very few components.

The design of the mixer was almost entirely empirical because of the lack of large signal data. The best compromise between noise figure and gain resulted when the FET was biased to a few hundred microamperes with the source resistor, (remember cathode bias) and then driven on with the local oscillator power. Better performance was obtained with the available local oscillator power when the local oscillator was introduced at the gate rather than at the source. The mixer output circuit is resonant at 28 MHz. The 51-ohm resistor terminates the receiver used with the converter and with L6, C6, and C7 determines the drain load impedance of Q3.

The local oscillator circuit is the same as the

Top view of the FET two meter converter.

Bottom view of the FET two meter converter.

one used by Frank Jones, W6AJF, in his converters shown in the June issue of 73. Briefly, L8 and C5 are resonant between the fundamental and the third overtone frequency. In this case L7 and C4 resonate at twice the third overtone frequency at 117 MHz. This results in an *if* frequency of 27 to 31 MHz. Other *if* frequencies could be used merely by selecting another crystal frequency and scaling the mixer output circuit to the desired frequency. For example, for 14 to 18 MHz use a 65 MHz crystal and double L6, C6, and C7.

The switch at the *if* output is used to switch the communications receiver between the converter and a low frequency antenna.

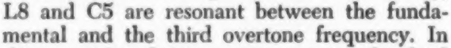


Fig. 2. Test setup used for cross modulation measurements.

Performance

The completed converter has a noise figure of just under 2.5 dB measured on a Hewlett Packard Noise Figure Meter. The gain from 144 to 28 MHz was measured and found to be 27 dB. Cross modulation measurements were made in order to compare performance with a conventional bipolar transistor converter. The setup shown in **Fig. 2** was used for these measurements. The attenuator was included in order to assure that cross modulation observed was not produced in the communications receiver.*

The converter-receiver combination was tuned to generator #1 at 145 MHz. Generator #1 was modulated 30% with a 1000-Hz tone, and the output level to the converter was 5 microvolts. The modulation on generator #1 was then turned off. Generator #2 was tuned to 146 MHz and modulated 30% with a 1000-Hz tone. The output level of generator #2 was then increased until the signal from generator #1 appeared to be modulated 1% (30 dB down on the VTVM). In ordinary use 1% represents a just detectable case of cross modulation.

This test was performed on both the converter described here and another using bipolar transistors. The results are shown below along with other comparative measurements:

	Bipolar	FET
Noise Figure	3.1 dB	2.4 dB
Gain	24 dB	27 dB
Rf input for 1% cross mod.	0.5 mV	27 mV

As can be seen the FET lives up to the claims made for it. 27 mV at the input means about 1 volt at the gate of the mixer where the cross modulation should be occurring. This improved performance means that fellow down the street would have to increase his power 2916 times in order to produce the same amount of interference.

On the air tests at the author's shack have confirmed the improvement in cross modulation resistance. With the bipolar converter, the modulation of a local repeater could be heard on every other signal on the band. With the FET converter, no detectable cross modulation has been observed from the repeater or any other local station in several months of operation.

Miscellaneous

Power for the converter here is supplied by a transistor transmitter used with it. There is plenty of room, however, to build a power supply into the converter. A suitable power supply is shown in **Fig.** 3.

The trimmer capacitors used here are quite expensive. They sell for more than the FETs. Almost any other good quality type would be a suitable substitute. Small ceramic trimmers could be used at a considerable saving.

For those who have an especially acute cross modulation problem, and who are willing to experiment, even better cross modulation performance than that obtained with this converter could be obtained with the common gate configuration. The common gate configuration is similar to grounded grid in a vacuum tube. The noise figure will be about 0.5 dB higher and the gain a little lower, but because of the lower impedance levels the voltages will be lower and remember it is the voltage that leads to cross modulation.

. . . K6HMO

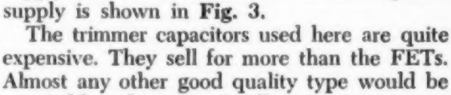


Fig. 3. Power supply suitable for use with the FET converter.

CAVEAT

EMPTOR?

No say the buyers of 73's fast growing want ad section. Caveat Emptor? CE's low price of $2 for 25 words (non-commercial ads) brings excellent results. You know why. 73 is read by the active, money-spending hams. Our want ads are the cheapest, and they're also set in clear, easy-to-read type with lots of space between them. And we're not nasty about the length, either: round the price off to the nearest dollar ($1 minimum) if you have more or fewer than 25 words.

We don't encourage businesses to advertise in Caveat Emptor? since 73's regular space rates are so low—as little as $18 for a 1/16th page display ad. But if you insist, the charge is $5 for 25 words, or $50 in advance for 25 words per month for a year.

A few hints for your ads. Type your copy. Don't abbreviate since you pay for words, not space. Include your full name and address as well as your call; not all hams have a Callbook, though they certainly should. We put the first few words in bold face capitals, so make them attract attention. Don't put "For Sale" in the ad; everyone knows that's what the ad is for unless you say otherwise.

Please type your ad on a large, plain piece of paper.

Send money and ad to:

Caveat Emptor?

73 Magazine, Peterborough, N.H. 03458

Wade Williams K5ILG
2327 Wheeling Avenue
El Paso, Texas

Electronic Thermometer

Although this instrument is not exactly in the category of ham radio equipment, it is of an electronic design and an excellent project for the gadget builder. It's an electronic thermometer that may be used for a remote temperature reading with a scale from −50 degrees C to 250 degrees C. You can also calibrate it in Fahrenheit degrees.

Thermistors are thermally sensitive resistors whose primary function is to show a change in electrical resistance with a change in temperature. They are extremely sensitive to minute changes in temperature. A characteristic of thermistors is their wide range of negative or positive temperature coefficients. Because the resistance of a thermistor is a function of ambient temperature, thermistors can be effectively used in devices to measure or control temperature. The high resistance of a thermistor as compared to the resistance of long leads makes possible accurate temperature measurements from remote locations . . . such as your operating desk.

The bridge circuit shown in **Fig.** 1 may be used as a deflection device where the output can be calibrated directly in temperature. An 0-1 mA meter is used as the indicator. It is a GE Type D.0.91, Catalog No. 512x22. The thermistor is G.E. 3D-054- 100Ω plus or minus 1% at 25 degrees C. For calibration of the bridge circuit close the Null Switch (R1) and adjust the potentiometer for minimum reading. Open the Null Switch and adjust R2 (150Ω pot) for calibration. Switch can be miniature (or standard) push button type for temperature readings. This bridge circuit can also be used as a null type of bridge where the variable resistance is adjusted to null the bridge output and calibrated in terms of temperature. The five resistors in this circuit *must* be of the precision type for accuracy.

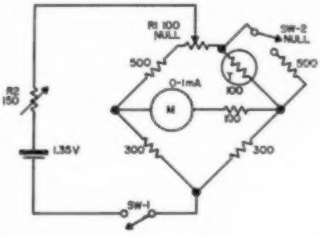


Fig. 1. Bridge type electronic thermometer. T is a GE thermistor as discussed in the text.

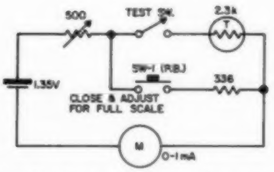


Fig. 2. Ohmeter type electronic thermometer. T is a thermistor. It's discussed in the text.

The ohmmeter type circuit as shown in **Fig.** 2 employs the GE Thermistor No. 2D-1119, 2.32 kΩ, plus or minus 1% at 25 degrees C. An 0-1 mA meter is used as the indicator. It is G.E. Type D.O. 91, Catalog No. 512x22. The 336Ω resistor must be one of precision type. For accuracy, components of best quality are recommended. The switch is a miniature or standard pushbutton type for temperature readings. If your dealer cannot supply you with the thermistor contact the General Electric Company, Magnetic Materials Section, P. O. Box 72, Edmore, Michigan. The price is $5.10 each.

Calibration of the meter is not difficult, although it takes a little time to calibrate the entire scale for normal use such as from −32 to 120 degrees F. A comparison thermometer of good quality is recommended.

It might be possible to use the thermistors which are incorporated in radiosondes and available at some surplus outlet. Inasmuch as these circuits are critical, considerable experimentation may be necessary to develop an accurate thermometer.

. . . K5ILG

TWO FOR THE ROAD

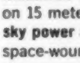
BIG-K

1000 watt (p.e.p.) mobile antenna at a mini-power price! Quick-connect high power inductors for 160*-80-40-20-15-10 meters have exceptional figure of merit—"Q"—that measures approximately 230 on 80, rises to 350 on 15 meters. **Webster invites comparison of this sky power antenna** particularly its high efficiency space-wound coils, **suspended**—not molded—inside a protective all-white tenite housing. **Compare** also the precision machined hinged column assembly that releases coil/whip for right-angle laydown—forward or to the rear. Lockup into operating position is equally fast. **Install BIG-K**—give your mobile signal a real sendoff. Two column sizes for bumper and deck mounting with overall lengths, respectively, of 93" and 77". And use the money you save to buy a fine Webster mount.

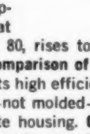
*160-meter coil 300W p.e.p.

Band-spanner

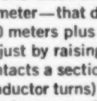
Want a fully streamlined car antenna that will handle 500W p.e.p.? **Buy Band-spanner** as thousands have over the past sixteen years. One clean-cut antenna—nowhere over 1⅛" in diameter—that delivers big sky power on 80-40-20-15-10 meters plus MARS. Band-change in seconds too just by raising or lowering the top whip (which contacts a section of any of the internally exposed inductor turns) and exact resonance on any in-band frequency. **Band-spanner**—truly streamlined—de-emphasizes the appearance of a fair size antenna on a new car. It has a two-tone fiberglass column and an attractive, epoxy-sealed loading section that blends both with car and surroundings. Two column lengths: Model ABB, 117" overall extended, 63" telescoped and Model ABD, 93" overall extended, and 60" telescoped.



Model THMD,
de luxe 3-hole
mobile mount.



Model BCM,
bumper chain mount.
(spring not supplied)



Model SHM,
single hole de luxe
mobile mount.

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Controlled Avalanche Silicon Rectifiers

Another improvement in solid-state electronics

To explain what Controlled Avalanche Silicon Rectifiers are and why they are better than conventional silicon rectifiers, we must first review a few rectifier facts.

Over the past several years, silicon rectifiers have been gradually replacing vacuum-tube rectifiers in the power supplies for electronic equipment, because of their high efficiency, compactness, and convenience. However, as almost everyone who has used them has discovered, silicon rectifiers are not foolproof, primarily because of their severe voltage limitations.

Under controlled conditions, silicon rectifiers with voltage ratings well above 1000 volts can be made, but 400 to 600 volt units are much easier and less-expensive to make.

When a rectifier is forward biased—anode positive with respect to its cathode—it will pass its rated current with a very small voltage drop across it. But when the rectifier is reverse biased (hooked up backwards, as it were), little current will flow through it in the reverse direction until the voltage reaches a critical value. Above this critical peak inverse voltage (piv) or peak reverse voltage point, the reverse current increases very rapidly. "Avalanches," as the solid-state engineers say. The combination of high voltage and high current can destroy a rectifier in microseconds.

Actually, the normal voltages present in solid-state rectifier systems are only a minor problem, because they are easy to determine. The big trouble is with voltage transients inside or outside the power supply. For example, lightning strikes have produced instantaneous voltage peaks up to 5600 volts on regular 120 volt power lines. In addition, an arcing switch, a chattering relay, a blown fuse, a momentary power interruption, or the opening or closing a switch at a crucial point of the AC cycle can all generate transient voltage spikes ten times as great as the normal peak inverse voltages across the rectifiers and blow them instantly.

Surge arrestors connected to various parts of the power supply circuit can cut transient voltage spikes down to size. But the rub is that they may cost far more than the rectifiers they are supposed to protect. Furthermore, the only way to determine the proper values for many protective devices is to measure the transient voltages on a fast writing oscilloscope or a peak-reading voltmeter and experimentally adjust values to reduce the transients to the lowest practical value.

Unfortunately, transients have a nasty habit of appearing to be cured and then popping up worse than ever when least expected. As a result, several rectifiers may be destroyed before the transients are suppressed.

Now, at long last, we come to the Controlled-Avalanche Silicon Rectifier. Remember that the reverse current through a conventional silicon rectifier "avalanches" or increases very rapidly when the peak inverse voltage across the rectifier exceeds a critical breakover value and destroys the rectifier. Taking a critical look at the well-known fact that, while transient voltages in rectifier circuits frequently reach very high peak values, they are normally of very short duration and contain little energy, the rectifier engineers reasoned: *if we can cause the rectifier's back resistance to decrease even more rapidly than in a conventional silicon rectifier at the breakover point, the low resistance will present a virtual short circuit to the transient and will chop off the voltage spike before it can damage the rectifier.*

To achieve their aims, the rectifier engineers carefully refined the silicon from which the new rectifiers were to be manufactured so that its resistivity would be uniform throughout the entire slab, instead of being composed of layers of different resistivities as in less-carefully processed silicon. In addition, they doped the silicon very precisely while forming the rectifying junctons to make their interfaces as smooth and as free of voids as possible.

In operation, the controlled avalanche rectifier performs exactly as theory predicted it would. Under normal conditions, it performs just like a conventional silicon rectifier, but when a transient voltage peak comes along, the avalanche effect slices off the peak before it can injure the rectifier.

High Voltage Operation. Controlled Avalanche rectifiers have another advantage in high-voltage power supplies. As mentioned earlier, silicon and other solid-state rectifiers are strictly limited as to the amount of voltage they can withstand. Consequently, to rectify high voltages with them, it is necessary to connect a number of low-voltage units in series. But this procedure produces complications with ordinary silicon rectifiers.

Conventional rectifiers show considerable difference between units in their back resistance and in the length of time that it takes them to recover their back resistance when the applied AC voltage swings from positive to negative. For thee reasons, it is usually necessary to connect equalizing resistors and capacitors across each rectifier in the string when conventional silicon recitifiers are connected in series. 0.02 μf capacitors and 1000 ohms per volt of rectifier piv are typical values.

But the controlled characteristics of controlled avalanche rectifiers usually eliminates the need for equalizing resistors and capacitors in series circuits.

Selecting Controlled Avalanche Rectifiers. Several of the well-known rectifier manufacturers, such as *GE, RCA,* and *Sarkes Tarzian,* are manufacturing controlled avalanche rectifiers. *Sarkes Tarzian,* in fact, is now furnishing the controlled avalanche type of rectifiers under the same type numbers and prices as of their older rectifiers which did not have this feature. Some other manufacturers make both controlled avalanche and conventional silicon rectifiers, and still others make only the conventional type. You, therefore, must exercise a little care in your selection if you want the new controlled avalanche type.

One way to identify controlled avalanche rectifiers is to check piv's in your electronics parts catalogue. Two of them are listed for the controlled avalanche rectifiers. Use the lower figure for designing the power supply. The higher "non-repetitious" or transient piv is the point at which transient voltage spikes will be chopped off.

Incidentally, when conventional silicon rectifiers are replaced with controlled avalanche rectifiers, it is not necessary to remove any protective devices already installed in the power supply. Leave them in for an extra safety factor, because controlled avalanche rectifiers are not cure-alls for all rectifier ills. Extra-energy transients can still damage a controlled avalanche rectifier, if the rectifier is not conservatively chosen. But the important fact is that the odds go up in your favor when you use them. . . . W9EGQ

The Touch Keyer

This simple circuit allows key-type operation without a key. The operator just touches the grid and taps out the CW with his finger. When you touch the sensor plate, a small current is applied to the gate of the SCR from the battery B1. This turns on the SCR, which supplies half-wave power to relay RY1 to energize the relay. Diode CR1 provides a return path for the relay-induced voltage and is necessary to prevent 60 cycle relay chatter. The SCR triggers when a low level positive current is applied to the gate of the SCR and turns off as soon as the current is removed. The low battery voltage along with the use of an isolation transformer provides no hazard to the operator. . . . David Metzger K8GVK

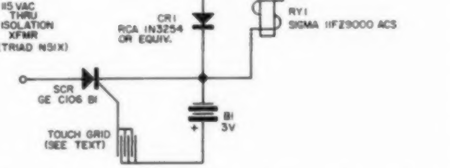
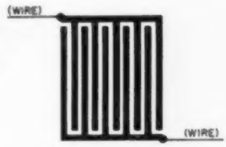
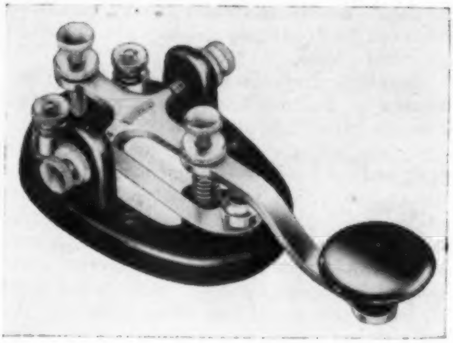


Fig. 1. Here's the ideal substitute for a key: Touching the touch plate with your finger turns on the silicon controlled rectifier (SCR), which throws the relay to key your transmitter.

Fig. 2. The touch grid can be made from etched circuit board like this, or can simply be two wires.





The straight key is the basic CW instrument. This is E. F. Johnson's model 114-310.

Jack Althouse WA6CEZ
Rt 3 Box 744-B-2
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Look What's Happened to the Telegraph Key!

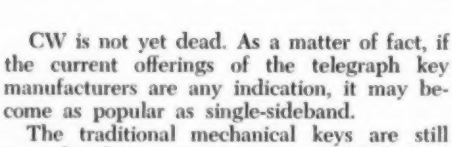
CW is not yet dead. As a matter of fact, if the current offerings of the telegraph key manufacturers are any indication, it may become as popular as single-sideband.

The traditional mechanical keys are still around and in a variety never available before. But the big new sound on the CW bands comes from the keyers—electronic devices using space-age circuits to make sending easy and more precise.

The electronic keyers require SPDT key action. So, for the first time in many years, the "Sideswiper" key is in the spotlight.

And there are keyers with features that result, strangely enough, from the popularity of voice-only SSB transceivers.

The new look in CW has brought forth a bewildering array of keys and keyers to suit the purposes of any CW operator. In this article we will describe the relative merits of the different keying methods and list the features of commercial keys and keyers.



A semi-automatic key by E. F. Johnson. Model 114-520.

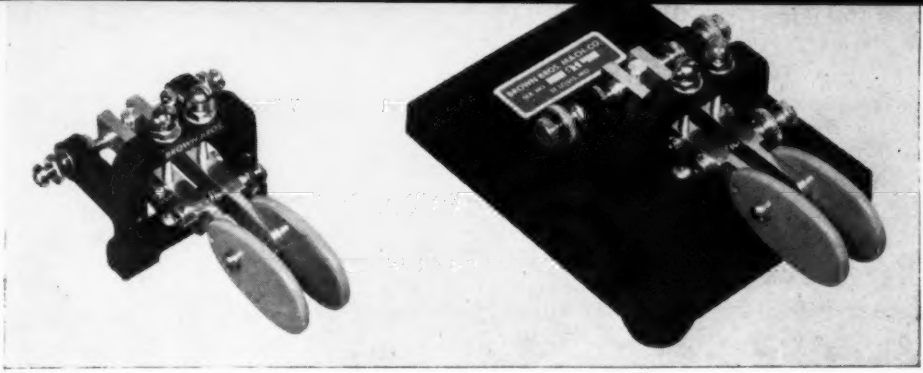
Straight keys

The time-honored straight key is universally present in ham shacks and commercial radio rooms. With its round black knob it hasn't changed much since before radio was born. Unless the FCC changes its mind about code exams it's likely to be around for a long time to come.

It's the only key recommended to the beginner for code practice and for operating on the novice bands. The amateur whose primary interest is in phone operation may never want anything more elaborate.

The E. F. Johnson Co. makes a complete line of straight keys ranging in price from $2.40 to $7.95. The lower priced keys are designed primarily for code practice. They have phenolic bases than *can* be cracked if screwed too tightly to the operating table. The more expensive models feature metal bases, smoother bearings and more precise adjustments. Keys are available with shorting switches (a feature important in wire telegraphy but not usually needed by the amateur radio operator) and in different decorative finishes.

The Brown Bros. model ST has a heavy square base that will not tilt under normal keying pressure. It is useful on a glass-topped desk where it would be difficult to screw down a conventional key.



Left. Brown Bros. model UTL sideswiper has tapped holes on front and bottom for mounting in custom electronic keyers. Right. For those who need a complete sideswiper, the UTL can be purchased mounted on a square base.

Semi-automatic keys

It's entirely possible to send CW at 30 wpm and above with a straight key. But it is difficult and soon becomes tiresome. Thus, for many years, operators have favored the "bug" or semi-automatic key. It makes a string of dots when the lever is pressed to the left. Dashes are made manually by moving the lever to the right. It is a vast improvement over the straight key for sending speeds above 15 wpm.

Although the semi-automatic key is substantially more expensive than the straight key, it stands out as a star performer in the fight against inflation. In 1925 the Vibroplex Co. advertised their "Bug" at $17. Forty years later their "Champion" model sells at $17.95. Other models with jeweled bearings, attractive finishes, and complete with cord and wedge range up to $33.95.

The wedge slips under the circuit closing switch of a straight key (if it has one) so that the semi-automatic key can be attached to the transmitter keying circuit without permanent wiring. It's useful to the commercial operator who takes his own key to work with him but is not generally used by amateurs.

The standard semi-automatic key is for right-handed operators but left-handed models are available.

Electronic keyers

The electronic keyer is the device that sits in the spotlight today. It's truly a product of the age of electronics.

The multivibrators, gates, binary counters and other circuits that came into widespread use with the advent of Radar led to experiments with electronic keyers more than twenty years ago. In the past few years several commercial designs have appeared.

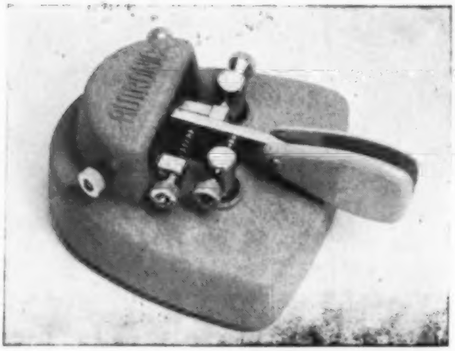
The electronic keyer uses a two-way lever. Press to the left and it makes a string of dots; press to the right and it makes a string of dashes. But that's not all. Just as a doughnut is not complete without a hole in the center, Morse code is not complete without proper spacing between the dots and dashes. Electronic keyers form the spaces with their "self-completing" action.

Here's how it works: Press the key to make a dash. Once the key has been lightly tapped the events to follow are temporarily out of the operator's control. The keyer *will* make a dash and then it *will* make a space. After the dash and the space are over the operator regains control and can call for the next dot or dash.

It's because of this "self-completing" feature that the first try at operating an electronic keyer can be a frightening experience. If the key is not pressed at the proper times the output is gibberish. But, once the technique is mastered, code spouts out of an electronic keyer with a machine-like precision that is pleasing to the ear. Dots, dashes and spaces are perfectly "weighted," that is, dots and spaces are exactly ⅓ as long as dashes.

Hallicrafters' model HA-1 at $79.95 is a typical keyer. It will operate at speeds from 10 to 65 wpm, has the self-completing feature

The Vibroplex "Blue Racer" is typical of the semi-automatic keys. The wedge, in foreground, connects to the station's straight key.



Electrophysics Corporation's "Autronic" key typifies the new generation of sideswipers.

and includes an audio oscillator to monitor sending through headphones or on its self-contained speaker.

Electrophysics Corp. markets a transistorized keyer at $79.50 with similar specifications. The panel lettering has been rotated 45° so it is readable with the keyer horizontal or set on end.

Sideswipers

The keyers described above require a separate key for their operation. It must have a SPDT action, one contact for dots, another for dashes. Pioneer builders of electronic keys had to make their own. One method was to adjust a semi-automatic key to have continuous closure on the dot side. Another was to place two straight keys back-to-back.

Today, keys designed especially for electronic keyers are available. Electrophysics Corporation's "Autronic" key, $19.95, takes less space on the operating table than either a straight or semi-automatic key.

AUTRONIC
ELECTROPHYSICS CORP.

The "Autronic" key by Electrophysics Corp. Only 2" high it can be placed on end to save desk space. In its semi-automatic mode dashes are made manually. This mode is used "key down" for transmitter tuning.

Brown Bros. model UTL, $10.95, is a key mechanism without a base for mounting on a home-brew keyer. Their interesting model CTL, $18.95, has a straight key and a sideswiper on a single base.

Both Vibroplex and Productive Tool make keys for electronic keyers that are similar in appearance and construction to semi-automatic keys.

SSB keyers

The keys and keyers described above are designed to key the transmitter carrier.

But what about the transmitters that don't have a carrier to key—SSB suppressed carrier transmitters? A few of the popular transceivers have provision for carrier injection so that they can be used for CW. Many do not.

Sideband Engineers has the answer to CW for the SSB operator in their "Codaptor." It works this way: Connect an audio oscillator to the microphone jack of a SSB transmitter and out comes a CW signal. Its frequency is above (USB) or below (LSB) the suppressed carrier

Left. The square base and rubber feet of this Brown Bros. key let it sit on the desk without screws. The double layer knob is known as the "Navy knob." Right. An unusual key by Brown Bros. On one base is a key for an electronic keyer and a standard straight key.

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ELECTRONIC KEYER

The Heathkit HD-10 has a paddle similar to those of semi-automatic keys. The "hold" position of the on-off switch is for transmitter tune-up.

frequency by the audio oscillator frequency. Key the audio oscillator and, presto, you're on CW.

The "Codaptor" also contains delay circuits that close the T-R relay of a transceiver before the keyed tone reaches the transmitter and keeps the relay closed, VOX fashion, for a time delay adjustable by a front panel control.

Integral electronic keyers

Two recently introduced keyers come with a built-in key mechanism. Waters Mfg. Co. offers a fully equipped package at $92.50. In one box it has a transistorized electronic keyer, a key, a tone oscillator for keying SSB transmitters and for monitoring, a mixer to combine the station receiver output with the sidetone oscillator, and its own battery supply. This, at present, seems to be the Cadillac of keyers.

the hallicrafters co.
T.O Keyer
FUNCTION
SPEED
MODEL HA-1
KEY

Hallicrafters model HA-1 keyer is based on a design by W9TO. The function switch provides two speed ranges and a "hold" position that keeps the transmitter on for tuning.

CODAX
AUTOMATIC KEYER
VOLUME
SPEED
WATERS
MODEL 361

The built-in key of the Waters keyer requires only 20 grams pressure for operation. This keyer will operate for more than 400 hours on its self-contained batteries.

For the do-it-yourself constructor there is the Heath model HD-10. The kit, at $39.95, has an integral key and operates from 115 V ac. It will also run on an external 45 volt battery.

Most straight or semi-automatic keys will switch a good deal of power. Electronic keyers have specified maximum voltages, currents, and power that they will switch. They should always be operated within the manufacturer's ratings.

The switching ratings and other data on representative keys and keyers are included in the following table. Any of the manufacturers listed will be happy to provide further information.

. . . WA6CEZ

CODAPTER
DELAY

SBE's "Codaptor" allows an SSB transceiver to be keyed with a straight or semi-automatic key. After the key is opened, the transceiver T-R relay remains closed for a time selected by the front-panel "Delay" control.

Manufacturer	**Model**	**Price**	**Type**	**Features**
Ameco Equipment Corp. 178 Herricks Rd. Mineola, L.I., N.Y.	K-1	$ 1.00	Straight Key	Phenolic base.
	K-2	$ 1.45	Straight Key	Adjustable bearings.
	K-3	$ 2.35	Straight Key	Metal base.
	K-4	$ 3.00	Straight Key	Brass base. Shorting switch.
Brown Bros. Mach. Co. 5370 Southwest Ave. St. Louis 39, Mo.	ST	$ 6.95	Straight Key	Heavy base. For glass-top desks.
	UTL	$10.95	Sideswiper	Key only. For home-brew keyers.
	BTL	$14.95	Sideswiper	Same as UTL with heavy base.
	CTL	$18.95	Sideswiper Straight Key	Two keys on one base.
Electrophysics Corp. 898 West 18th St. Costa Mesa, Calif. 92627 "Autronic"	—	$19.95	Sideswiper	Compact. Use on glass-top desks.
	—	$79.50	Electronic Keyer	Transistorized, compact, for grid-block keying, switches 105 V @ 80 mA. High power switching transistors available.
Hallicrafters Fifth & Kostner Avenues Chicago 24, Ill.	HA-1	$79.95	Electronic Keyer	Mercury-wetted relay switches 5-amp 250 V 250-watts max.
Heath Company Benton Harbor, Mich. 49023 "Heathkit"	HD-10	$39.95	Electronic Keyer Kit	Transistorized, integral key, for grid block keying, switches negative 105 V @ 35 mA.
E. F. Johnson Co. Waseca, Minn.	114-300	$ 2.40	Straight Key	Phenolic base.
	114-301	$ 2.50	Straight Key	Phenolic base. Adjustable bearings.
	114-310	$ 3.50	Straight Key	Metal base. Takes wedge.
	114-310-2	$ 4.25	Straight Key	Shorting switch.
	114-311	$ 5.50	Straight Key	114-310 but chrome plated.
	114-311-3	$ 6.50	Straight Key	114-310-3 but chrome plated.
	114-100	$ 6.95	Straight Key	Brass base. Fully adjustable.
	114-100-3	$ 7.75	Straight Key	114-100 with shorting switch.
	114-520	$17.75	Semi-automatic	Circuit closing switch.
	114-500	$20.30	Semi-automatic	Fully adjustable. ⅛" contacts.
	115-501	$25.50	Semi-automatic	Fully adjustable. ¼" contacts.
Productive Tool & Mfg. Co., Inc. 9 Market Street Stamford, Conn.	"Nikey"	$17.95	Sideswiper	Dual lever, heavy base.
Sideband Engineers 317 Roebling Road South San Francisco, Calif.	"Codaptor"	$39.95	SSB Keyer	T-R relay control, adjustable VOX delay.
Waters Mfg. Inc. Wayland, Mass. "Codax"	361	$92.50	Electronic Keyer	Transistorized. Integral key. Switches 250 V dc, 1-amp, 15-watts max. Reed relay switch. Battery operated (batteries not supplied).
The Vibroplex Co., Inc. 833 Broadway New York 3, N.Y.	Vibro-Keyer	$17.95	Sideswiper	Heavy base. Fully adjustable.
	Champion	$17.95	Semi-automatic	Heavy base.
	Blue Racer	$22.45[1]	Semi-automatic	Compact size. Jewelled movement.
	Presentation	$33.95	Semi-automatic	Gold plated. Fully adjustable.

[1]—Cord and wedge at extra cost.

"The Bug" and "Vibroplex" are trade marks of the Vibroplex Co.

'Codax" is a trade mark of the Waters Mfg. Co.
"Heathkit" is a trademark of the Heath Co.

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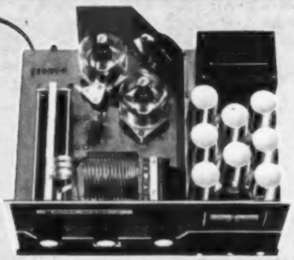

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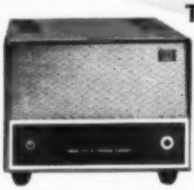

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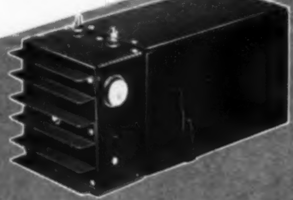

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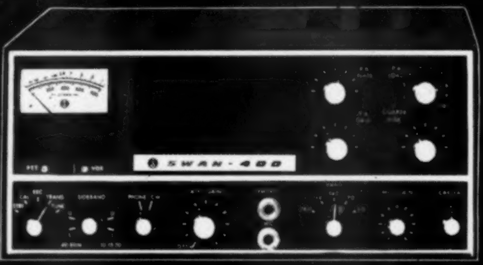

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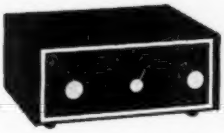

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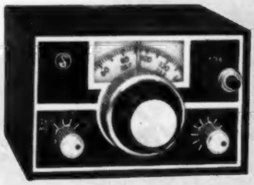

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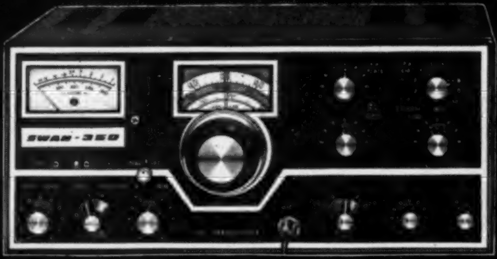

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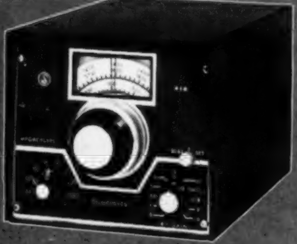

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MODEL 22 . . . . $25

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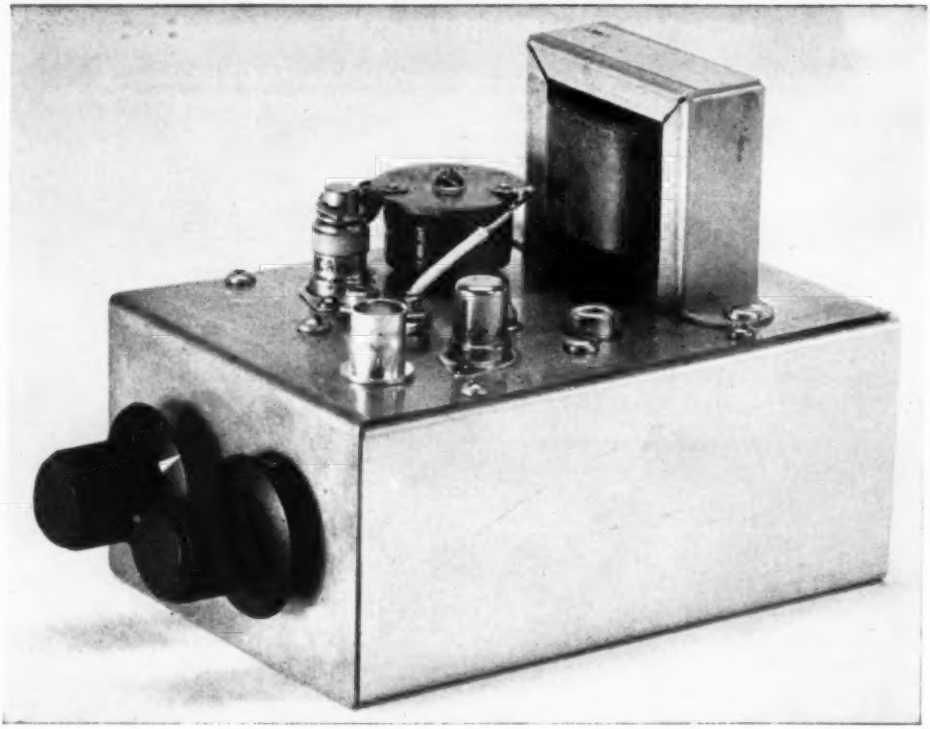
240 watts PEP. **$325**

SWAN ELECTRONICS CORP.
Oceanside, California



Don Nelson WB2EGZ
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Ashland, N.J. 08003

A Poor Man's 220 MHz Receiver

Simplicity wins again with this easy-to-build receiver for local contacts on the 220 MHz band.

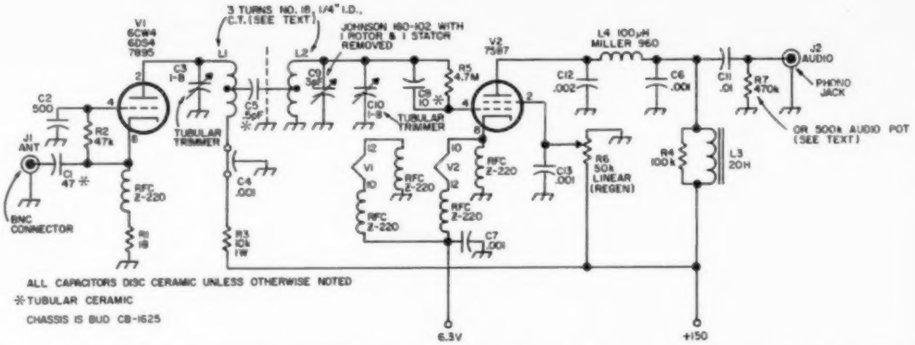
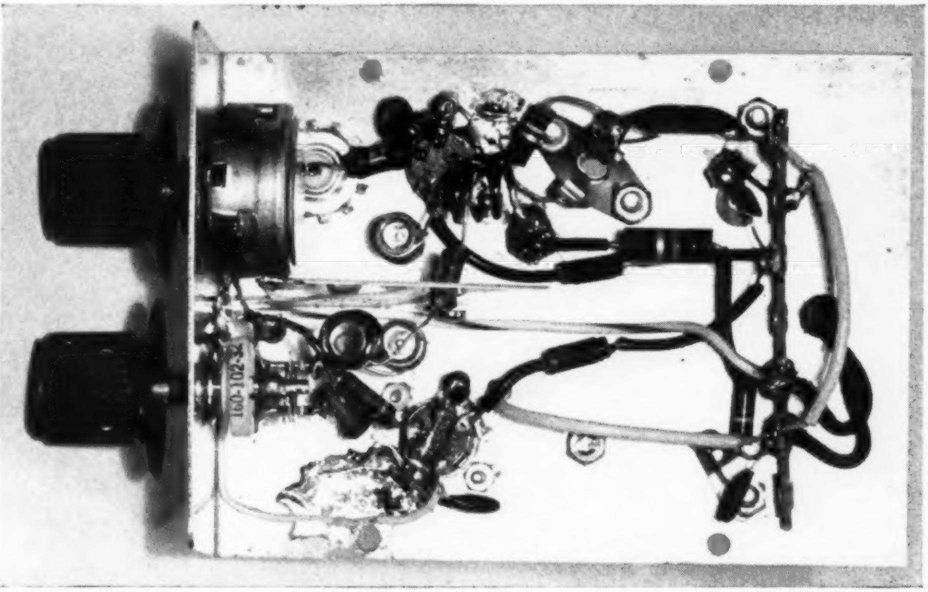

V1
6CW4
6DS4
7895
3 TURNS NO. 18, 1/4" I.D.,
C.T. (SEE TEXT)
JOHNSON 160-102 WITH
1 ROTOR & 1 STATOR
REMOVED
L1
L2
C3
1-8
C2
500
R2
47k
J1
ANT
C1
47 *
TUBULAR
TRIMMER
C5
.5pF
*
C9
3pF
C10
1-8
TUBULAR
TRIMMER
C8
10 *
R5
4.7M
V2
7587
RFC
Z-220
BNC
CONNECTOR
R1
18
C4
.001
R3
10k
1W
12
V1
10
RFC
Z-220
10
V2
12
RFC
Z-220
C7
.001
L4 100µH
MILLER 960
C12
.002
C6
.001
C11
.01
R7
470k
J2
AUDIO
PHONO
JACK
OR 500k AUDIO POT
(SEE TEXT)
C13
.001
R6
50k
LINEAR
(REGEN)
R4
100k
L3
20H
6.3V
+150
ALL CAPACITORS DISC CERAMIC UNLESS OTHERWISE NOTED
* TUBULAR CERAMIC
CHASSIS IS BUD CB-1625

Fig. 1. A Poor Man's 220 MHz Receiver. This receiver is suitable for use with any simple audio amplifier or it may be integrated with the Poor Man's Transmitter in the August 73.

In the August 73, I left the realm of sophistication to describe a simple, low power 220 MHz transmitter which has enjoyed a remarkable performance record. Here is the companion receiver—a two tube superregenerative unit which may be constructed on the same chassis as the transmitter. Perhaps you would prefer to listen to 220 before building a transmitter. In that case, try this inexpensive receiver with any small audio amplifier.

The "superregen" has a few disadvantages on a crowded band, but crowds are rare on 220. On the east coast, DX'ers congregate near 220 MHz with local club activity at 220.5 MHz and 221.4 MHz. This receiver will easily separate the major frequencies. A grounded grid preamplifier serves to increase the sensitivity of the receiver, and minimizes detector radiation to the antenna. The grounded grid configuration has the advantage of minimizing overload problems if you live near a high power transmitter (such as TV or



Underside of the Poor Man's 220 MHz Receiver. As you can see, construction is very simple. This receiver was built as a unit, but it's easv to build the circuit into the transmitter.

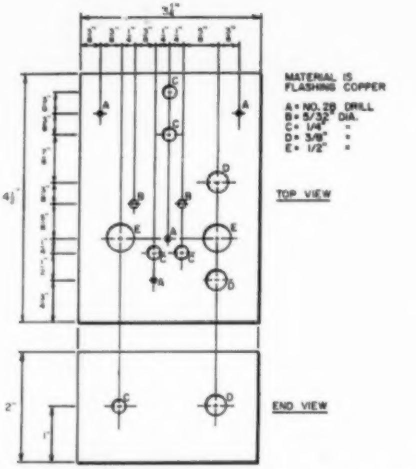


Fig. 2. Layout of the 220 MHz receiver. ⅓ size.

another 220 ham station). A Nuvistor tetrode detector from K6CJN in the June '63, 73 is still a fine performer at 220, giving very good selectivity.

Thin copper is recommended for chassis material if it is available, but this receiver was breadboarded on aluminum with satisfactory performance. The regeneration control was mounted on the front panel with the tuning control. One might prefer a volume control in front with the regen control on the rear. This is not critical so long as the screen bypass capacitor is located at the tube. An adapter must be made to use a ¼" knob with the tuning capacitor. This is most easily accomplished with a short piece of ¼" copper tubing. Careful work, short leads and good solder joints will pay dividends—Take your time!

With the tube heaters on, adjust C_3 to resonate L_1 at 221 MHz using a grid dip meter. Next, close the plates of C_9, the tuning capacitor, and tune C_{10} to resonate L_3 at 218 MHz. Values have been chosen to cover tuning from 218 to 228 MHz. Final adjustments should be made while receiving a weak signal.

Correct operation of a superregenerative receiver is dependent on the coupling of the tuning tank (L_2, C_9) to the preceeding stage. Superregeneration might be called partial oscillation—as such it is dependent on a correct amount of feedback.

The trick to making a useful superregenerative receiver is to keep the regeneration constant over the entire tuning range. This is done by selecting the correct point on the coil (L2) for the tap. The point farthest from ground at which regeneration is constant is the most desirable. This is a critical adjustment which makes the difference between a winner and "another old dog from a magazine." In this receiver it is practical to tap both L_1 and L_2 at the same approximate points, but small adjustments to perfection need only be made in the tap of L_2.

You may notice that the tuning of L_1 is changed by adjustment of C_9 because of the capacitive coupling between tanks. Such coupling in no way degrades the performance of the receiver and was found to be the most stable circuit of several circuits which were tried. Selectivity may be broadened by reducing the value of R_5 to 1 megohm. At the same time, sensitivity will be increased. Selection of R_5's value will vary with the amount of activity in your area, and to some degree, individual taste.

Happiness is listening to 220. Gene (WB2CVF) breadboarded the receiver and had it working in one Sunday. With slightly less talent applied to the second unit, the author's receiver was performing perfectly after three weeks of spare time and a little help from Gene. Not all was grim, however. A few bugs in the original design were exterminated in the second unit. Hopefully, you will find the project to be a pleasant task for several evenings. With the help of a good antenna, reliable 25 mile reception is no problem.

The author wishes to thank Steve Wojcik for the photography.

. . . WB2EGZ

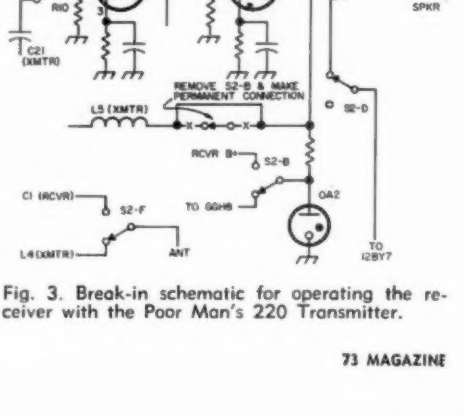

NOTES
S2 IS A 5-POLE 2-POSITION STEATITE WAFER SWITCH (SHOWN IN TRANSMIT POSITION)
RECEIVER HEATERS ARE ON AT ALL TIMES

Fig. 3. Break-in schematic for operating the receiver with the Poor Man's 220 Transmitter.

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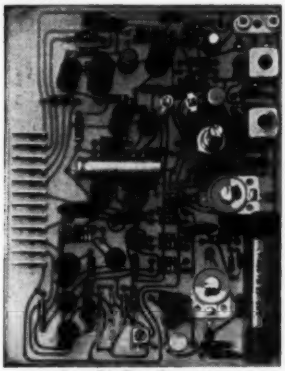
Front Panel View
B-1000A



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Amateur Television—Let's Get Started: Part I

Been thinking of getting on ham TV? This article explains how with all the information you need.

Many is the amateur who has started in amateur television only to be frustrated by poor results. There have been many articles over the years on individual systems,[1] but little information available to the amateur on setting up a complete system and making it work. In these two articles, the author attempts to relate his experiences with the hope of answering some of the many questions on the adjustment of the TV system.

First, let us review some of the terms used in television work.

Video: That portion of the television signal containing the picture information. (Fig. 1).
Synchronization or *sync:* That portion of the signal containing the timing pulses used to lock the monitor to the camera.
Blanking: That portion of the picture used to determine picture edges.
Set-up: The point of reference black. Setup is nominally 7.5 per cent of the 100 units alotted to the picture.
Composite television signal: A TV signal containing all of the above.

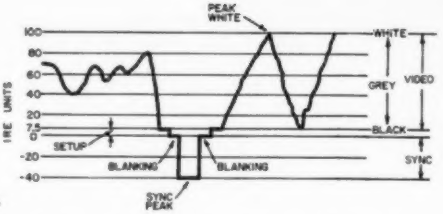

Fig. 1. Part of the standard TV signal. This drawing shows a horizontal sync pulse and video along with the standard IRE reference scale.

Resolution: The ability to detect detail. Horizontal resolution is measured by use of vertical lines and is determined by the number of vertical lines that can be seen in three fourths the picture width. Vertical resolution is measured with horizontal lines and is limited to a maximum of 525 due to the fact that 525 lines are the number sent by the scanning system. If interlace is not used, the resolution is limited to about 250 lines. This is because the two fields which are composed of every other horizontal line are not precisely locked together. Normally, the amateur does not use interlace so the amateur signal comes under the 250 line category.

Bandwidth: The total spectrum needed to send a television signal. Bandwidth is related to horizontal resolution by a factor of 80 lines per megahertz. More on this when we discuss modulators and modulated amplifiers.

Scan linearity: The ability to reproduce all parts of the picture in correct proportions. An example of poor vertical linearity is the stretched heads on a TV receiver caused by improper adjustment of the vertical linearity control. Most amateur cameras have no provisions for adjusting linearity per se, but do have height and width adjustments. These should be set for a width to height ratio of four to three.

Luminance linearity: The ability to reproduce all shades of grey from black to white correctly.

Ringing: An effect on the picture producing multiple images on either side of the main object; caused by overpeaked video amplifiers in the camera system. This is a high frequency distortion in the range above one megahertz.

Ghosting: Similar to ringing, except occurring only to the right side of the main object, and caused by improperly terminated coax lines, either video or rf, or by multipath reception when seen on an off-the-air signal.

Streaking: An effect producing a smear on the right side of an object extending for considerable distance, often to the end of the picture. A good example is often seen when white names are flashed on a relatively dark picture such as during the credits rolling by at the end of a commercial program. Caused by distortion at frequencies around 15-45 kHz and difficult to correct.

Smearing: An effect similar to streaking, but occurring over the whole picture giving the whole picture a muddy look. Also caused by low frequency distortion usually below 100 kHz. The effects of some of these distortions will be covered later.

Figs. 2 and **3** show the composite television signal at the vertical and horizontal rates respectively. Both traces are useful in signal analysis. The video, sync, set-up, and blanking are shown. Also note the scale used. This is the IRE^2 standard scale used to measure relative amplitudes of portions of the signal. The complete waveform equals 140 IRE units. Note that zero reference is at blanking. The sync occupies 40 units, set-up is 7.5 plus or minus 2.5 units and the video is nominally 92.5 units of information. The whole 140 units

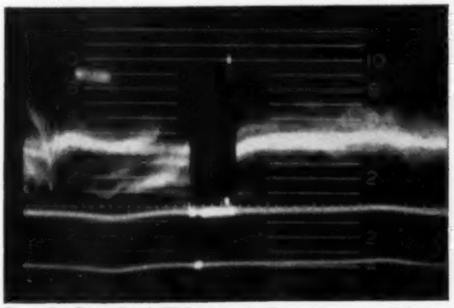

Fig. 2. Standard TV signal. Scope sweep 30 Hz amplitude one volt. The blank interval in the center is vertical blanking. Ten corresponds to 100 IRE units on the scale.

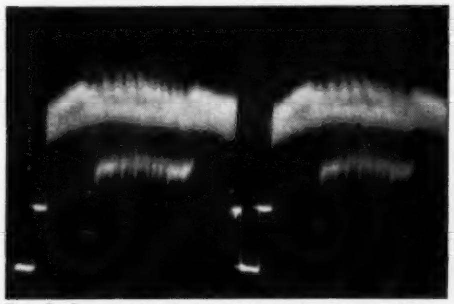

Fig. 3. Standard television signal-horizontal. Scope sweep 7875 Hz. Horizontal sync and blanking are clearly evident. Note also that the black parts of the picture extend down to almost plus 7.5 IRE units.

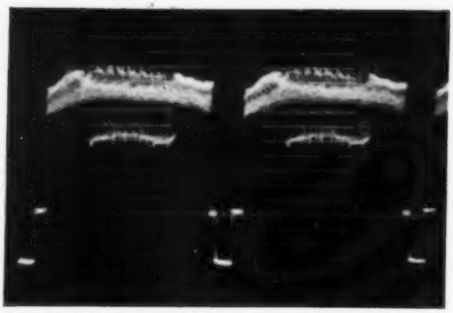

Fig. 4. High Set-up. Note blacks only extend down to plus 45 IRE units. The Camera video gain is too low. This results in a washed out picture.

correspond to one volt peak to peak. The blackest blacks occur at plus 7.5 units while the whitest whites occur at plus 100 units. Varying shades of grey occur between these limits. If a picture has no blacks, the peaks of the video would not extend down to plus 7.5. **Fig. 4** shows a video signal with such a condition. Here note the 'high set-up'. This is a normal signal if the picture corresponding to this scope trace had no blacks. If, upon knowing that the picture contained actual blacks, this scope pattern would indicate that video gain is too low and set-up is too high. Most amateur cameras have no provision for adjusting set-up, but do have provisions for adjusting gain. A camera with too little video gain will normally appear like **Fig. 4**, having the appearance of too high a set-up. The camera gain should be adjusted, when on a picture with whites and blacks such that the blackest blacks extend down to plus 7.5 IRE units. While it is desirable to keep the camera output at one volt, what is more important is the correct sync to video ratio of four to 9.25 as shown in **Figs. 2** and **3.** Since most cameras have no control over sync gain, the nominal 4 to 10 ratio should be maintained in preference to maintaining the output at one volt. Adjust the camera to obtain pictures as close as possible to **Figs. 1, 2,** and **3.**

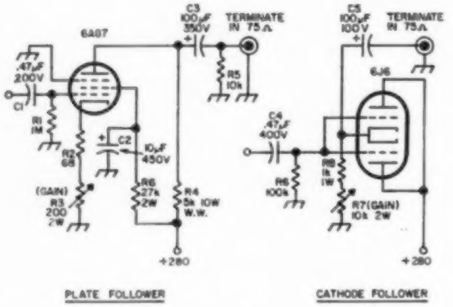

Fig. 5. Camera output stages

Test equipment

In order to make adjustments to the TV system, some test equipment is a must. We have already made reference to the scope. This is the most important item. Most any scope will do, but the higher priced wide-band units are best. In addition, acquire a good picture monitor (TV set). In order to view the picture before it goes through the transmitter, a means of tying the monitor and camera together must be employed. The biggest problem is polarity of the video. The standard method of running video around the shack is 'black negative' as shown on all the scope waveforms in this article. You should check your particular camera to see if the output is black negative and also to see if the output is low impedance, specifically 75 ohms. If both of these criteria are met, good. If not, **Fig. 5** shows the answer. Both circuits will make the camera low impedance, but the cathode follower should be used if the polarity of your high Z output camera is correct. If you find the blacks and sync positive going, use the plate follower circuit. This will invert the signal and provide the necessary low impedance output. Both of these circuits will enable you to use several hundred feet of camera cable.

Now that the camera has a low impedance output, additional equipment can be hung on as in **Fig. 6.** Note that the cable is terminated only once in 75 ohms at the end. All equipment including monitors and the modulator should be 'looped through' making one continuous line. Avoid tee connections. These will introduce ghosts even with the line matched. At K3ADS, the modulator has the 75 ohm termination built in so this unit is at the end of the line.

In order to make this low impedance signal useful in the TV set, a circuit is needed to bridge the camera output cable. **Fig. 7** shows a simple video amplifier that can be mounted in the TV set. Power can come from the set. Take the output and probe around in the video amplifiers to find a point where the picture

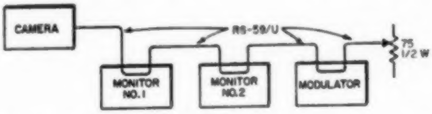

Fig. 6. 'Looping Thru' method of tying several equipments together on one video line.

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	401-R	144-148	7-11
	401-S	143.5-148.5	30-35
6M	401-B1	50-51	.6-1.6
	401-B2	51-52	.6-1.6
	401-C1	50-54	7-11
	401-C2	50-54	14-18
	401-J	50-52	28-30
20M	401-G	13.6-14.6	.6-1.6
CB	401-A1	26.5-27.5	.6-1.6
	401-A2	26.8-27.3	3.5-4.0
40M	401-K	7-8	.6-1.6
CHU	401-L	3.35	1.0
WWV	401-H	5.0	1.0
Int'l. Marine	401-11	9-10	.6-1.6
	401-12	15-16	.6-1.6
	401-M	2-3	.6-1.6
Aircraft	401-N1	118-119	.6-1.6
	401-N2	119-120	.6-1.6
	401-N3	120-121	.6-1.6
	401-N4	121-122	.6-1.6
	401-N5	122-123	.6-1.6
	401-N6	123-124	.6-1.6
Fire, Police etc.	401-P1	154-155	.6-1.6
	401-P2	155-156	.6-1.6
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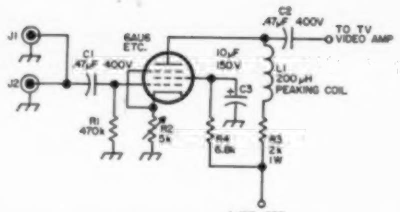


Fig. 7. TV set video preamp. Most TV sets need additional amplification for satisfactory results from one volt of video.

comes out in the correct polarity. Most of the older sets contain two video amplifier stages so it should be possible to find a point with sufficient gain to get a contrasty picture of the correct polarity. If not, use an additional stage to reverse the polarity. The plate resistors are of low value to improve frequency response and consequently, the gain of each stage is low. Now that the monitor is connected, the camera performance can be evaluated.

Test patterns and their uses

There are two popular test patterns available to the amateur. One is the familiar Indianhead pattern and the other the EIA[3] pattern, **Fig. 8.** The EIA pattern is preferred since it has ten shades of grey as compared to five on the Indianhead, but either are satisfactory. For those using one of the ATJ series cameras with a slide projector, these patterns are available as slides.[4]

Set up the camera facing the pattern and adjust the controls to obtain a picture. Adjust beam, target, focus, and gain for as good a picture as possible and then check to see that the camera 'sees' the complete pattern *exactly*. Adjust the camera height and width for the proper four to three aspect ratio as seen on a *properly adjusted monitor*. The monitor can be set correctly by getting up *early* one morning and using the test pattern transmitted by a local commercial station. If the monitor cannot be adjusted for a perfect pattern, remember the error and adjust the camera for a pattern similar to that seen from the commercial station. This way, the scanning error often present in TV sets can be compensated for.

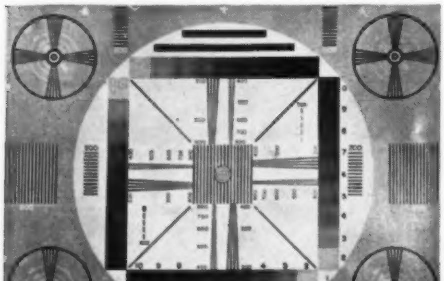


Fig. 8. EIA test pattern

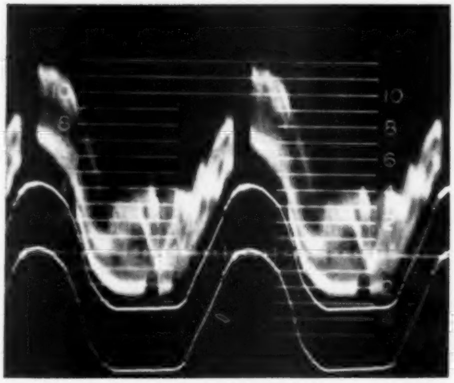


Fig. 9. 60 Hz hum scope at 30 Hz sweep. 120 Hz hum will have twice as many alternations. This amount is severe. Any hum over 10 IRE units is objectionable with levels over 40 IRE units destroying the picture.

On the test pattern, the horizontal and vertical wedges are calibrated directly in lines of resolution. It should be possible to obtain a horizontal resolution of from 200 lines on the ATJ series iconoscopes to 300 to 500 lines resolution on live vidicon cameras. On vertical resolution, the patterns will seem to come alive on the horizontal wedges. This pattern, called moiré is caused by the convergence of the wedges being nearly parallel to the scanning lines. This is an optical effect and should be ignored.

Other troubles

Fig. 9 shows the effect of hum. This is best observed with the scope looking at the vertical information. The ripples appear on the waveform monitor while horizontal bars appear on the picture monitor. In severe cases, the picture will gyrate with the hum. One black and one white bar indicate 60 Hz hum,

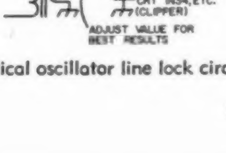


Fig. 10. Vertical oscillator line lock circuit.

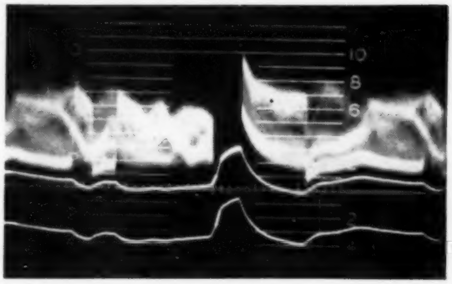


Fig. 11. Clamping failure. In amateur equipment, usually caused by defective coupling capacitors.

while two pairs indicate 120 Hz trouble. The former is caused by poor grounds between the camera, monitor, modulator, and other equipment. Also this hum can be caused by heater to cathode shorts in video amplifiers or by defective power supplies using half wave rectification. 120 Hz hum is always caused by defective full wave power supplies. Use plenty of filtering. 80 to 100 μF capacitors should be used whenever possible. To further minimize this effect, be sure the vertical oscillator in the camera is locked to the power line. **Fig. 10** shows a simple circuit which can be used.

Another problem occurring often is distorted vertical blanking as shown in **Fig. 11.** This is often caused by defective coupling capacitors in video amplifiers such as C3 in **Fig. 5.** Bad tubes also can cause this defect. Use the scope here to locate the defective stage by starting at the output and working back.

Most amateur cameras use free running horizontal oscillators. In order to get this oscillator close to commercial standards, lock in a commercial signal on the monitor, then switch to the local signal. If the horizontal oscillator in the receiver goes out of sync, adjust the horizontal oscillator in the camera until the picture stays locked in when switching back and forth between the commercial station and the local signal.

The off-the-air receiver

In order to check the operation of the TV transmitter when it is completed and to view the signals of other ATV stations, a 440 MHz receiver is needed. As a starter a modified UHF-TV converter can be used. Avoid modifying all-channel receivers. While these work fine for UHF TV, they do not have built in trimmer capacitors in most cases, making tracking difficult and almost impossible after conversion. Whatever converter you use, be sure it has an *if* amplifier. If transistorized, care must be taken to insure the rf from your own transmitter does not burn out the transistors in the converter.[5]

A popular converter for ATV is a modified Blonder-Tongue BTU-2 series. These use low noise diodes and 6ER5 frame grid tubes in *if*. A method of conversion suggested by K3KFL is to solder small two-turn gimmicks across the oscillator and preselector trimmer piston capacitors. Use number 20 plastic coated hookup wire for this. On late model Blonder Tongue units, the trimmer on the oscillator has been eliminated. In these units, remove the cover over the 6AF4A tube socket and solder the gimmick across the one already under the cover. Using a weak UHF-TV station, UHF signal generator, or regular 432 MHz amateur station, adjust the oscillator to cover from about 435 MHz up and *carefully* adjust the preselectors for best signal to noise. In addition to the above types of stations, radar-like signals and two way communications stations may be heard. If these are steady, they may be used for alignment. With care, the converter will still have high gain and good tracking up thru channel 50 or 60 and can still be used for UHF-TV reception.

When the system is completed and satisfactory pictures are being sent and received, then it is time to think of a good low-noise and, in this age, transistorized converter for 440. However adequate results can be had with a UHF converter and I suggest leaving the high sensitivity converter a project until after completion of the transmitter. Good rf amplifiers make an improvement over the UHF converter but because of the wide bandwidth of the TV receiver, the improvement is not as drastic as that observed on a phone signal.

Nexth month, we'll cover modulators, the modulated amplifier, and antenna systems. Meanwhile dig out the camera again. See you on 440.

. . . K3ADS

1. Kaiser, "A UHF Television Transmitter", *CQ*, April 1962.
   Daskam, "¾ Meter TV", *73*, Match 1964.
   Kennedy-Colby, "The ARC 26 TV Transmitter", *73*, June 1963.
   Hutton, "Amateur TV Transmitter", *73*, March, 1963.
   Taylor, "NSTC Signal for Ham TV", *73*, January 1963.
   Haines, "What's A Vidicon", *73*, Sept. 1962.
2. IRE Scale (IEEE) IRE Standard 23.S1, and the recommendations of the Joint Committee of TV Broadcasters and Manufacturers for Coordination of Video Levels.
3. EIA-Electronic Industries Association. Standard Test Pattern adopted in 1956.
4. Test patterns are available from Denson Electronics, Rockville, Conn.
5. Jones, "432 MHz Transistor Converter", *73*, June 1966.
   Reference: *Television Signal Analysis*, Second Edition, American Telephone and Telegraph Company, Long Lines Department 1963.

E. R. Davisson K9VXL
83 Crestview Drive
Greenwood, Indiana

The Multical

A many-use, many-frequency crystal calibrator.

What is the "Multical"? As the name implies, "multi" would suggest several uses, and "cal" might infer a calibrator of some sort.

Well, that's right, but there is slightly more significance to the name. "Multi" is also a short form term used to describe flip-flop circuits known as multivibrators.

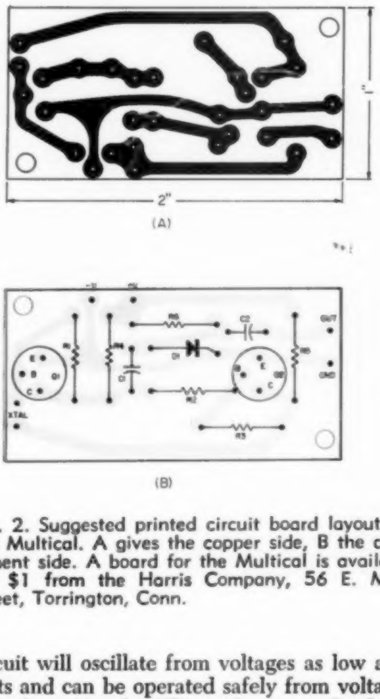
By combining the basic characteristics of a free-running multivibrator (astable) with crystal control, you have a simple, stable, virtually-insensitive-to-temperature-changes, crystal calibrator for that receiver you have been wondering about.

The circuit uses no inductors and depends upon the crystal for the proper feedback for oscillations. Temperature stability is partially due to the absence of capacitors.

Transistor stage Q_2 operates with unity gain, whereas transistor Q_1 operates at considerably more gain. Both stages are operating as feedback amplifiers. The harmonic generator diode D_1 is a 1N128. Any general purpose diode may be used.

By using the multivibrator circuit, the waveform obtained is comparatively rich in harmonics and could be used without any further refinements. However, to insure useful harmonics through 30 MHz starting from a 100 kHz crystal, a harmonic generator consisting of R_6 and D_1 shown in **Fig. 1** was added. The capacitors C_1 and C_2 are used strictly for coupling and have no effect on frequency stability.

Crystals from 100 kHz up to 1 MHz may be used in the Multical with no changes. The circuit will oscillate from voltages as low as 2 volts and can be operated safely from voltages as high as 20 volts. This wide range of voltage operation allows the source to be obtained from virtually any place.



(A)

(B)

Fig. 2. Suggested printed circuit board layout for the Multical. A gives the copper side, B the component side. A board for the Multical is available for $1 from the Harris Company, 56 E. Main Street, Torrington, Conn.

Output from the calibrator may be fed directly into the receiver's input, or may be coupled to a short whip antenna. With a whip antenna, close coupling to the receiver's input may be required at higher frequencies. (Especially at the lower voltage levels.)

For the more ambitious builders, **Fig. 2** shows the printed circuit board layout for the Multical. Due to its small physical size (1" x 2"), room can probably be found even in the most compact of receivers. **Fig. 2A** shows the foil side, and **2B** shows the parts placement.

So the next time you wonder about the accuracy of your receiver calibration, give this simple circuit a try and you'll know for sure.

. . . K9VXL

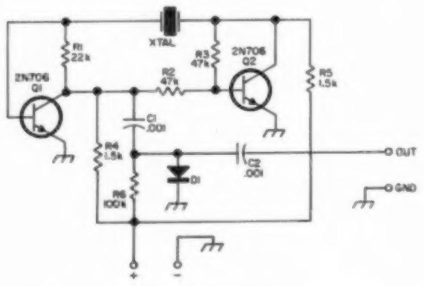


Fig. 1. Schematic of the Multical.

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Connectors for Those Surplus Coaxial Tubes

"Tubes I have, sockets I do not have," and they want too much money for them. Also many of the sockets available in surplus do not have the built-in by-pass connectors. My problem came up when I wanted to make use of some 4X150A, 2C39A, and 2C40 type tubes for vhf-uhf amplifiers and needed connectors to attach to the external electrodes and sheet by-pass capacitors. As I began work on the projects, I remembered an article by WB6AOW[1] and tried my hand at making the connectors as he suggested. I had trouble getting the finger stock to stay in place as I added them around the ring. I would get one positioned and another would slide out of place as I soldered the next one in place. I gave this up as a bad job and started searching for a better solution.

In the junk box I found some ten-thousandths (0.010") shim stock, and while looking at it, I came up with this idea for making connectors that work as well as the commercial ones. The process produces a symmetrical connector of uniform thickness permitting the calculation of the capacitance for by-pass purposes.

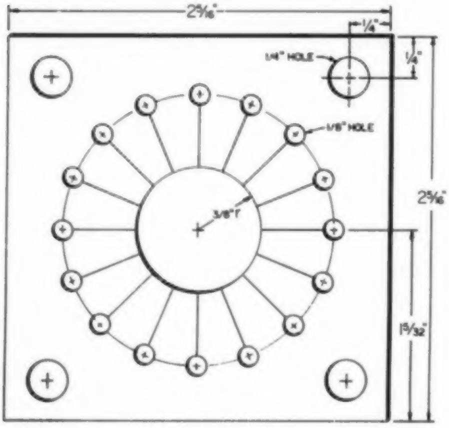


Fig. 1. Stock layout for 4X150A screen bypass.

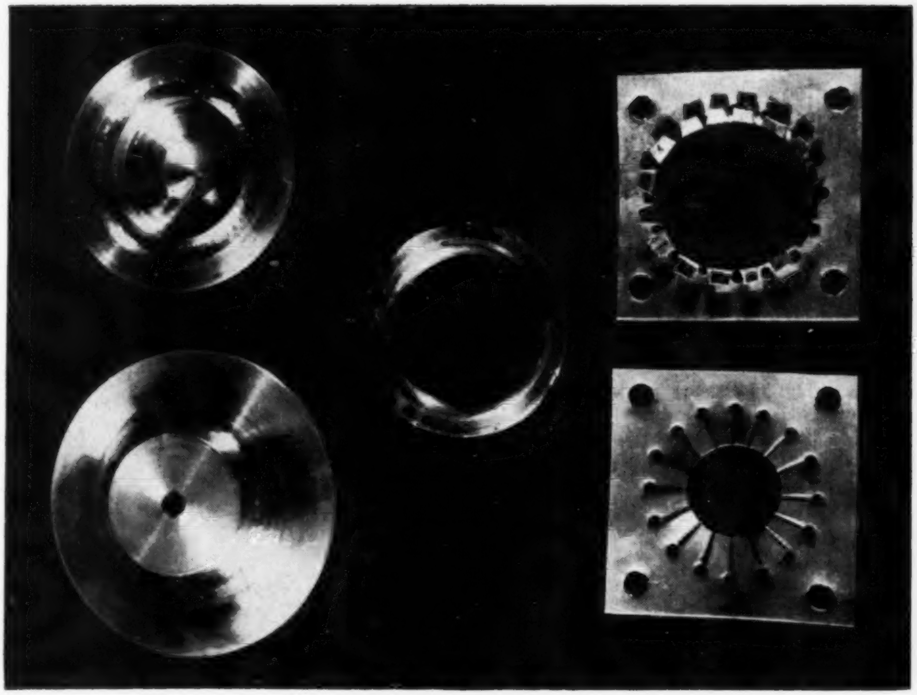
The first few that I made were rolled by hand, without the jig described, and were not as symmetrical as the later ones but worked quite well nevertheless. The connectors made in the jig were perfect fits and more uniform. The steps for making the connectors from shim stock can be easily duplicated in your own shack. The jig will require the use of a metal lathe, but the resulting connector is worth it. The dimensions for the jig and connector described here are for a screen by-pass connector for a 4X150A tube. For other coaxial tubes the dimensions will have to be altered accordingly.

The shim stock is prepared as follows:

1. Lay out the stock per the dimensions in **Fig. 1.**
2. Drill out all holes and punch out the center with a chassis punch.
3. Cut slits with a pair of scissors from the knock-out to the stop holes to form the fingers. (Roll the fingers by hand using round nose pliers or make yourself the jig.)
4. Place the stock on the base of the jig.
5. Force the washer down into place over the stock and then remove the washer leaving the stock on the base.
6. Force the top die down over the top of the base.
7. Remove the finished connector and install in the cavity or on the socket.

The jig is made of steel stock and is turned on a lathe according to the dimensions in Fig. 2. When turning the washer be sure to allow for the thickness of the stock or it will be difficult to remove in step 5. The top die must fit very closely or it will not catch the fingers and roll them properly. Shim stock of .005" and .015" were also tried and it was found

Bill is a professor of science at the State University of New York at Albany. He's taught a number of electronics and ham courses, including one on WTEN-TV.



On the left are the jig base and top, in the center is the jig ring, and on the right are a piece of stock ready to be formed and a finished connector.

that the .010 stock was the most satisfactory.

If the connectors are going to be used as grid connectors on planer triodes, do not use the top die, but use the connector as finished following the pressing of the washer on the jig base in step 5. When using two or more tubes in parallel or with common push-pull connection, you can make the connector of a single plate, laying out both tubes and punching on the jig twice. The photograph shows a finished connector, the stock lay-out, and the jig. The only inherent problem is that a jig must be manufactured for each diameter connector that you desire to make, but once the jig is made, it may be used forever and supply connectors for other members of your club. Make some of those vitally needed connectors and use those surplus high frequency tubes that have been gathering dust in the junk box. P.S. I don't own a lathe either. John Kowalchyk, a machinist friend, helped produce the first jigs that were made from the drawings. Later he was able to show me how to set up and use the lathe. This permitted me to make others myself. Joe Kelly, a fellow teacher, made the photograph.

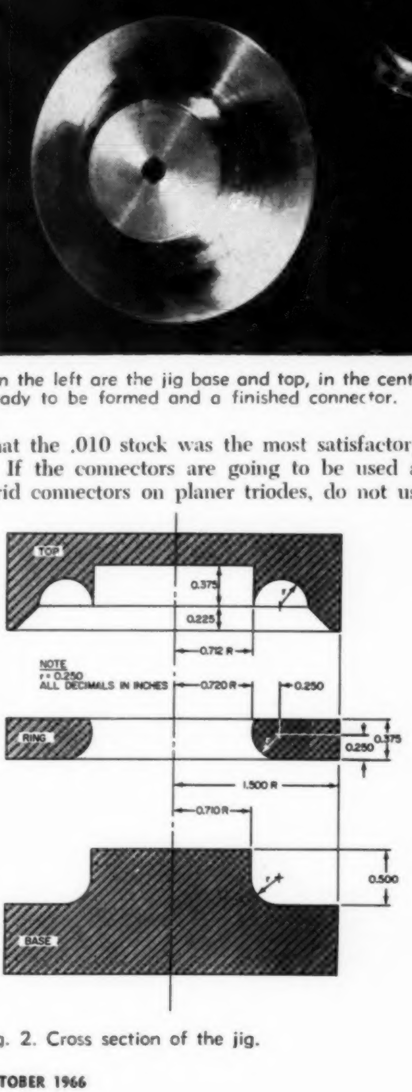


Fig. 2. Cross section of the jig.

. . . K2ZEL

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1. Griffin, Frank WB6AOW, "Do-It-Yourself 4X150 Sockets," **VHF Horizons**, April 1963.

Fred J. Dietrich WØIFY/8
97 East Lakeview Ave.
Columbus, Ohio 43202

A DX Vertical

Here's a simple, effective antenna you can put up in almost no space.

The situation was about as impossible as one could imagine. The rig was a home-brew 100 watt cw transmitter with no drive above 20 meters, the receiver a none too stable 20 year old model, the back yard was full of power and telephone lines, the roof was fragile, slick slate, the rig was on the second floor, the line noise was often greater than S9, and I wanted to work DX! To make matters worse, the budget wouldn't allow more than about five dollars for an antenna, and being a student didn't leave much time for scrounging.

An important consideration was that of size, together with selection of the band or bands to be worked. Listening on a 67 foot wire that ran to a 25 foot high tree in the back yard revealed that the only two reasonable candidates for DX were 20 and 40 meters because of the sunspot situation. This wire had been used in an end-fed manner with a little DX success on 40 meters, but the competition from 40 meter beams and foreign broadcast stations made things pretty tough. The situation on 20 meters was about the same; it worked well for domestic contacts, but fell pretty flat when I tried to work DX.

In order to get the best DX coverage, it is necessary to put as much of the transmitter power as possible into the lowest radiation angle possible. This is so because most of the reduction in signal strength that takes place on an ionospherically reflected wave takes place where the wave passes through the lower layers of the ionosphere. The lower the radiation angle of the antenna, the fewer hops it takes to go between your QTH and those juicy DX locations. Also important is the fact that waves which take off at high radiation angles frequently pass through the ionosphere and are lost. This, of course, is just wasted power.

A study of the vertical radiation patterns for various horizontal antennas which appear in the first part of the ARRL Antenna Book reveals that it is necessary to get a horizontal dipole a half-wavelength or more high in order that the radiation angle be reasonably low. It is also important to notice that even if the antenna is fairly high, there is usually a good deal of radiation in power-wasting high-angle lobes. A fairly good compromise is a height of five-eighths wavelength. This gives a radiation maximum at about 25 degrees above the horizon, with something like 25 per cent of the power going into high-angle radiation. For 20 meters, this height comes out to something like 40 feet, and since there was nothing this high to attach to, a horizontal dipole seemed not too promising.

The vertical radiation patterns shown for a vertical dipole, on the other hand, are much more promising. In particular, the pattern for a vertical dipole with its center one quarter-wave above the ground (this means the lower end of the dipole is right next to the ground) shows a radiation pattern maximum at lower than ten degrees elevation angle when the antenna is located over average, not perfect, ground. There is also no loss of power at high angles because there are no extra lobes. This seemed to be the answer for working DX within the limitations of my QTH. A vertical dipole for 40 meters would be 70 feet high, a pretty tall order for the $5.00 budget and also for the limited space available for the guys which would be required for a mast of this height. For 20 meters, the height came out to be 33 feet 2 inches for the CW band, a height which could be supported by the house alone.

The antenna was mounted as shown in **Fig. 1**. The support points are the bottom of the mast and a point about two-thirds up the mast. This has proved adequate in winds up to 50

Fred is a research associate for the Ohio State University Antenna Laboratory. He has a BSEE, MSEE (Purdue), and is working on his PhD.

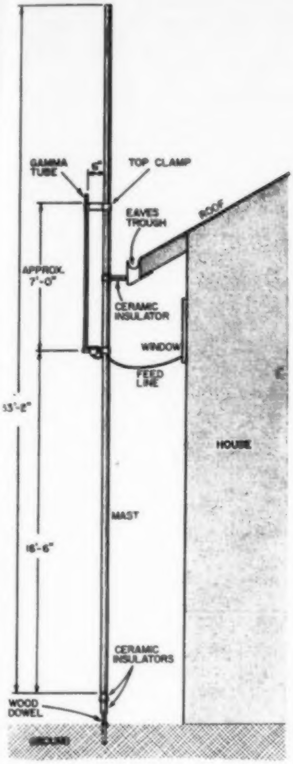
GAMMA TUBE
5"
TOP CLAMP
EAVES TROUGH
ROOF
APPROX. 7'-0"
CERAMIC INSULATOR
WINDOW
FEED LINE
33'-2"
HOUSE
MAST
16'-6"
CERAMIC INSULATORS
WOOD DOWEL
GROUND

FIG. 1
GENERAL ARRANGEMENT

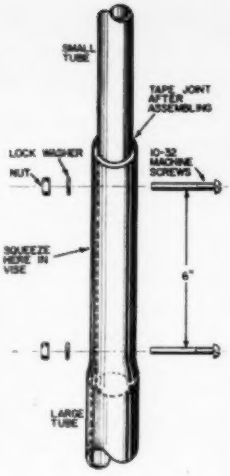
SMALL TUBE
TAPE JOINT AFTER ASSEMBLING
LOCK WASHER
NUT
10-32 MACHINE SCREWS
SQUEEZE HERE IN VISE
6"
LARGE TUBE

FIG. 2
MAST JOINT DETAIL

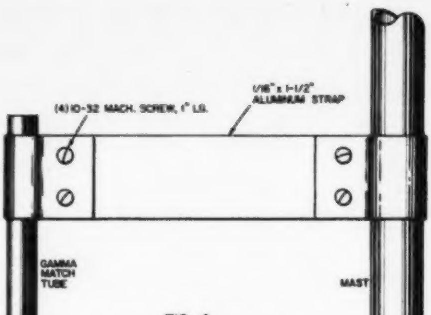
(4) 10-32 MACH. SCREW, 1" LG.
1/16" x 1-1/2" ALUMINUM STRAP
GAMMA MATCH TUBE
MAST

FIG. 4
TOP CLAMP DETAIL

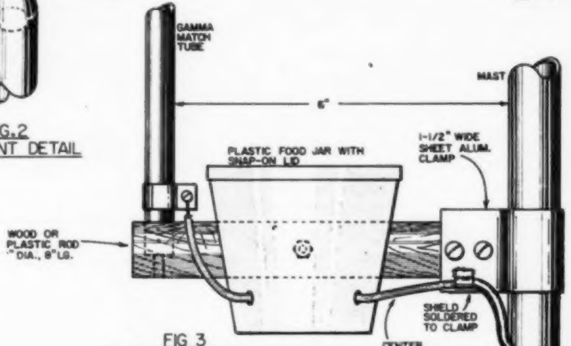
GAMMA MATCH TUBE
MAST
6"
PLASTIC FOOD JAR WITH SNAP-ON LID
1-1/2" WIDE SHEET ALUM. CLAMP
WOOD OR PLASTIC ROD 1" DIA., 6" LG.
SHIELD SOLDERED TO CLAMP
CENTER CONDUCTOR
COAX TO SHACK

FIG. 3
FEED-POINT DETAIL

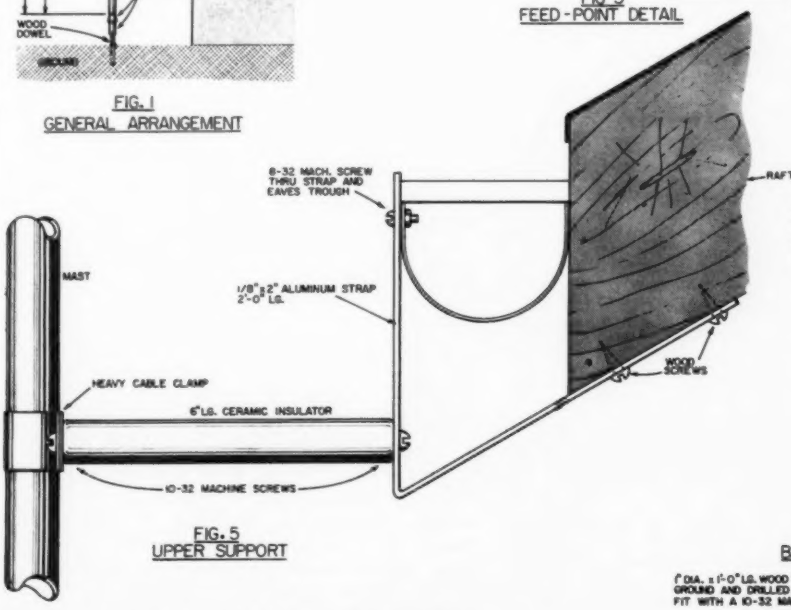
8-32 MACH. SCREW THRU STRAP AND EAVES TROUGH
RAFTER
MAST
1/8" x 2" ALUMINUM STRAP 2'-0" LG.
WOOD SCREWS
HEAVY CABLE CLAMP
6" LG. CERAMIC INSULATOR
10-32 MACHINE SCREWS

FIG. 5
UPPER SUPPORT

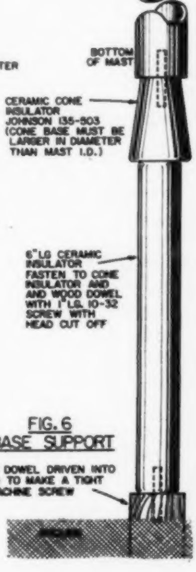
BOTTOM OF MAST
CERAMIC CONE INSULATOR JOHNSON 135-503 (CONE BASE MUST BE LARGER IN DIAMETER THAN MAST I.D.)
6" LG CERAMIC INSULATOR FASTEN TO CONE INSULATOR AND AND WOOD DOWEL WITH 1" LG. 10-32 SCREW WITH HEAD CUT OFF
1" DIA. x 1'-0" LG. WOOD DOWEL DRIVEN INTO GROUND AND DRILLED TO MAKE A TIGHT FIT WITH A 10-32 MACHINE SCREW
GROUND

FIG. 6
BASE SUPPORT

NOTE - ALL HARDWARE CADMIUM PLATED OR STAINLESS STEEL.

or 60 miles per hour, the highest usually encountered in this location. Since the dipole is a full half-wavelength long, it is conventional to feed it at the center. This turned out to be a rather convenient point in this case, as it fell near the height of a window in the second-floor shack. I chose to feed it with a gamma match to avoid splitting the mast in the center and to provide an unbalanced coax feedline. It should work equally well as a vertical doublet.

The antenna mast itself was assembled from various pieces of scrap aluminum tubing which were purchased during one morning's scrounging. If nice, long sections of telescoping tubing are available, by all means use them; I wasn't so lucky, but I still got the thing put together. In my particular one, the bottom 10 feet is a piece of one inch aluminum conduit, the center section is a two section thinwall aluminum TV mast about 13 feet long, the next section is a discarded TV antenna boom with the elements removed, and the remainder of the 33 foot 2 inch length is made up of two pieces of aluminum tubing scrap. This length was found from the equation $L = 468/f(\text{MHz})$ where L is in feet.

Since the tubing didn't telescope together nicely, it was necessary to devise some means of fastening them together. This was accomplished by squeezing the larger of the two tubes for a particular joint in a vise until it was narrow enough to provide a tight fit for the smaller tube. The joint was then bolted with two bolts about six inches apart through both tubes. **Fig. 2** illustrates the method. All the joints were taped with plastic electrical tape after they were assembled to keep moisture out. Cadmium plated hardware was used everywhere to prevent corrosion and rust. Stainless steel hardware would be even better, but I have seen no signs of rust after two years with the hardware I used.

Fig. 3 shows the details of the gamma feed arrangement. The gamma tube is fed from the center conductor of the coax through a 33 pF variable capacitor which is enclosed in a plastic refrigerator jar to protect it from the weather. It is important to drill a small hole in the bottom of the jar to allow condensation to drain out. I learned this the hard way. I didn't provide a hole, and after about 6 months of operation there was about a half inch of water standing in the bottom of the jar. Changes in barometric pressure cause the jar to "breathe" humidity inside. The top of the jar is removed to adjust the capacitor during initial tuning. Once it is tuned, the lid is snapped back in place. The jar attached to the wooden dowel with a long 6-32 screw which passes through the dowel, through the jar, and screws into one of the mounting holes of the variable capacitor. This joint was sealed with mastic cement between the jar and the dowel to prevent rain from entering the jar at this point.

The gamma tube is supported on the bottom by being set into a hole drilled partway through the dowel. This should be of such a size to provide a snug fit for the tube. A small hole, concentric with the large one, was drilled entirely through the dowel to allow rain to pass freely through the gamma tube and out the bottom. The electrical connection is made at the bottom of the tube by means of a clamp made from scrap sheet aluminum and fastened with a 6-32 machine screw which also holds the solder lug for the wire from the capacitor. This joint was taped after completion of the antenna. The top clamp is shown in **Fig. 4**, and consists merely of a piece of sheet aluminum formed into clamps at both ends.

Fig. 5 and **6** show the details of mounting. The long ceramic insulators shown happened to be on hand; probably something smaller in size would be adequate. The mast turned out to be only about three feet from the wall of the house. A larger spacing would be desirable from the standpoint of efficiency, but the property line prevented it.

Adjustment of the gamma match proceeded as follows. The transmitter frequency was set to the center of the desired frequency range (in my case it was 14050 kHz) and the output power was adjusted for the minimum required to give full-scale deflection on the SWR meter. (An SWR meter or impedance bridge[1] is essential for the proper tuning of any antenna system.) If possible, choose a time when the band is dead so as to cause a minimum of interference. Before keying the transmitter, set the top gamma tube clamp to some position, say 6 feet above the center of the antenna, and tighten it. (now take your hands off the thing!) Key the transmitter and adjust the variable capacitor until the standing wave ratio is minimum. If the reading at minimum is too high, move the clamp up or down a few inches and repeat the procedure. If this improves the SWR, move the clamp again in the same direction. If the SWR goes up, move the clamp in the opposite direction. If the SWR cannot be brought to a satisfactory level, it might be necessary to move the center clamp on the antenna up or down a few inches. The part of the antenna which is close to the wall of the house will be somewhat detuned by the house, and the electrical center of the antenna might not be located at the exact mechanical center. It should be possible to get the SWR down to

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[1] Kyle, Jim, "R.F. Measurements," 73, Dec. 1965, p. 20.

1 to 1 at the center frequency; I quit when I hit 1.25 to 1. It stays below 1.75 to 1 anywhere in the CW band, which is entirely satisfactory for all but the most touchy transmitter pi-network.

The tuning was accomplished by having one man on an extension ladder and the other at the rig. Since the total feed line length for my installation was only seven feet, and the window it passed through was left open during the tuning procedure, there was no problem of communication between the man at the rig and the man on the ladder.

A convenient feature of this antenna is the ease with which it may be lowered for inspection and repair. It is necessary only to remove one screw from the upper insulator, disconnect the feed line from the transmitter, tie a strong cord to it above the center, and lower away. I am able to do this from inside the shack by opening the upper half of the window. To raise it, it is necessary to have someone position the bottom of the mast over the bottom cone insulator and hold it there while I raise it back to a vertical position. The XYL performs this task admirably.

A note about radials. One of the reasons for selecting this type antenna is that it is center fed and does not require radials for efficient operation. The more popular vertical is a quarter-wave type which must be fed against a radial system or some other form of ground. The reason that many of these fail to live up to their expectations is because of an inadequate counterpoise. A single ground rod at the base of a quarter-wave antenna is usually not adequate. I know; I've tried it with disastrous results! The transmitter power is dissipated in large ground resistance which results from a poor ground. A good system of buried radials is excellent for a quarter-wave vertical, and a system of radials above ground for the popular ground plane antenna works well. I did not have room near or in the ground, and the fragile roof and a landlord who discouraged me from walking on it prevented the erection of anything on the roof.

I did try stringing some radials in the basement and feeding the whole mast against these for 40 meter operation using a variation of the bazooka balun feed, but that's another story.

On the air results have been very encouraging in the relatively little operating time I've had available. A check in the log shows mostly 569 and 579 reports out of Europe and 589's out of Central and South America. Since I am restricted to Saturday morning operation, I don't usually hear the Asian and Pacific stations.

. . . WØIFY/8

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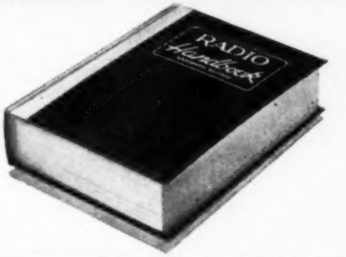

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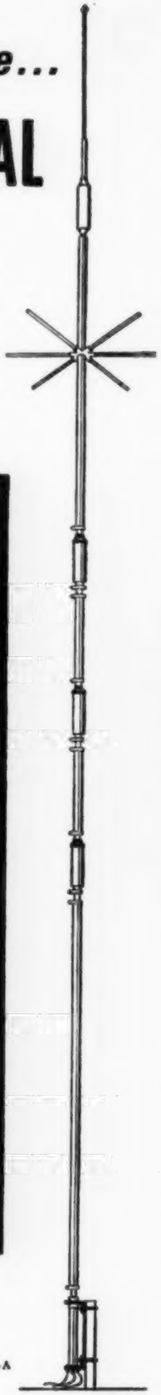

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6439-A

Jim Kyle K5JKX
1236 NE 44th St.
Oklahoma City, Okla.

An AC Voltbox

Does the line voltage tend to wander about a bit at your QTH? Or are you checking out new gear and needing a way to simulate high or low line-voltage conditions?

One way out of these (and all similar) problems is to buy an adjustable autotransformer. General Radio calls them "Variacs" and other people have other names for the gadgets, but they're not too unfamiliar.

However, they *are* expensive. In sizes rated for any power capability at all, they begin to make sizable dents in the region of the pocketbook. Even in surplus!

Another way out of the problem is to build yourself a voltbox. It won't have *quite* the flexibility of the variable transformer, but on the other hand it won't cost nearly as much either. In fact, you can build a stripped version out of most anybody's junkbox.

The trick of hooking up a low-voltage transformer so that its secondary is in series with the line voltage is as old as the hills. It must even have had whiskers when Signore Marconi tapped out his famous three dits. And that's the basis of the voltbox.

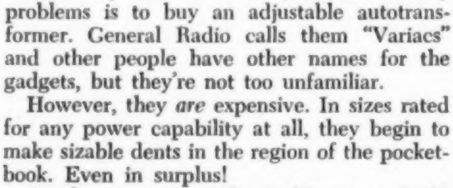

Fig. 1. Schematic diagram for voltbox. T1 can be any filament transformer. Power capacity of voltbox will be product of transformer secondary current rating and (line voltage minus secondary voltage). F1 should be rated same as secondary of T1. As shown, output voltage will be (line minus secondary) at switch position 1, (line minus half secondary) at position 2, straight line at 3, (line plus half secondary) at 4, and (line plus full secondary) at 5. If secondary windings happen to be reversed in polarity from that shown, only effect will be to make position 1 the **high** end of the range and position 5 the low.

But it's a bit more than that. The simple series-secondary hookup is fine for either boosting or lowering line voltage by a fixed amount. It even lends itself to use of a dpdt switch to take your pick of boost *or* cut. But it's not much for rapid control.

By using a center-tapped filament transformer, however, and a 2-pole rotary switch with 5 positions, it's not too hard to get a sort of "active power rheostat" effect. The schematic shows the hookup. In position 1 of the switch, the full secondary of the transformer is in series with the line and out of phase, so that if we're using a 10-volt center-tapped transformer and have a constant line voltage of 115 the Voltbox output will be 105 volts at this point.

Position 2 cuts out half the secondary, so we have only 5 volts to work with, but retains the same phasing. Now we have 110 volts out.

Position 3 eliminates the transformer altogether for straight through 115-volt operation. Position 4 is the same as position 2 but the phase is now such that our 5 volts *adds;* we get 120 volts out. Finally, position 5 adds the full 10 volts for 125-volt output.

So by the twist of a switch, we go from 105 to 125 volts in 5-volt steps. Had we used a 25-volt center-tapped transformer, the range would have been from 90 to 140 volts in 12½-volt steps.

The fuse shown in the schematic is for the protection of the transformer; the voltmeter across the output socket is simply a convenience so that you can monitor output voltage constantly.

Some TV power transformers have double 6.3-volt secondary windings, with at least one of them centertapped, as well as a 5-volt rectifier winding. These can be used to build a really wide-range Voltbox; the output steps could be arranged as 97.4, 102.4, 108.7, 111.85, 115 (line), 118.15, 121.3, 127.6, and 132.6. This would require a 9-position 2-pole switch. Wiring would follow that of the schematic except that all secondaries would be hooked up in series with the center-tapped winding at the bottom of the string and the 5-volt winding at the top. Measuring secondary voltages from the bottom of the string, you would have 3.15, 6.3, 12.6, and 17.6 volts. The bottom connection would go to switch position 1 on wafer A and the 17.6-volt end would go to positions 1, 2, 3, and 4 on wafer B and 6, 7, 8, and 9 on wafer A. Intermediate connections would go to 2, 3, and 4 on A (in order) while positions 1 through 4 on A would connect to 6 through 9 on B in the same way as 1 and 2 connect to 4 and 5 in the schematic; positions 5 on both wafers connect together for a straight-through connection.

In such a hookup, power rating would be limited by the lowest current rating of the individual windings. Thus maximum output current might not be greater than 600 ma, or about 70 watts worth of power at 117 volts.

In the hookup shown in the schematic, power rating is equal to the current rating of the secondary multiplied by the *lowest* output voltage. It will increase at higher output voltages but this provides you a safety margin. Using a 10-volt 5-amp transformer you'll have a power rating of more than 500 watts—plenty to run any receiver or VFO, and adequate for a performance test on much other equipment.

The same idea can be applied as an input-power control for a low-power transmitter, since output of a 600-volt power supply can be varied over a ±50-volt range by the 105/125 volt range of the Voltbox. You'll probably discover dozens more uses for this handy gadget as soon as you have it finished and use it for a while!

. . . K5JKX

Parts Storage

Cigar boxes are much more satisfactory for storing small parts than the plastic drawer type cabinets. If you have ever tried to close a drawer full of resistors you will know what I mean.

First it is important to stock up on all types of cigar boxes. To do this you will probably have to get on the cigar store waiting list. When you have a sufficient assortment of boxes take the ones of the same size for each type of component you want to store. Over a period of time and with enough shuffling from one box to the other, and end result will be a neat storage for your small parts.

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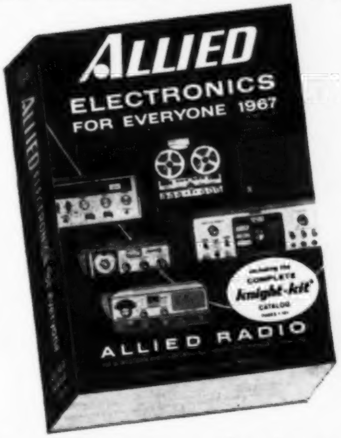

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Gus Browning W4BPD
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Gus: Part 16

Last month I was on Aldabra Island having a ball. After repairing the Teflon needle valve with a hot soldering iron and getting my antennas broadside to the USA and Europe, I was all set for the pile-ups.

I found that there were interesting things to observe on the islands. I saw the Booby birds trying to battle their way thru with their craw full of fish every evening (read last month's issue). Or take those coconut crabs that invaded the back porch where I was operating every night. These are mean rascals about twice the size of both of your fists when placed together. They just love to sneak up on you at night (they don't come out in the daytime), and when you are not watching all of a sudden they will take a snip at your leg; I mean right up under your pants cuffs. They are always fighting each other; usually every morning there were a number of dead ones laying around that got killed during the night. I think they hate each other and think nothing at all about "battling to their death" at the first sight of another one. Sometimes when I awoke by the operating position in the morning there even were a few dead ones on top of the table. I suppose they climbed up on the table via the overhanging table cloth. I guess they would make FB house pets if you did not want any of your neighbors visiting you. One night I caught about 25 of them and placed them in a large box so that I could take a picture of them the next day, but the next morning every one of them was dead. I suppose they had a real battle royal in that box during the night. All of them were snipped up; pieces of coconut crabs were all over the box; not a whole one was to be found.

Another interesting type of nightly visitor was some extra large bats. I will tell you of my encounter with one of them the very first night I was there. My operating table was on the back unscreened porch. I had been noticing something flitting between me and the light bulb a number of times, and thought possibly it was a large candle fly or something like that. I had a nice pile-up going, operating SSB on 20 meters. Someone had just called me and I was about to jot down the call sign of the station calling, but all of a sudden, something lit on top of my partly bald head. This "thing" was straddling my headphone band (the mike was also mounted from this headphone band) and its claws were dug into my very thin hair and scalp. I yelled into the mike, "Just a minute, Buddy, I got some trouble here." Then I sort of sneaked my hand up to my head to feel this thing that was on top of it, nice and soft. I quickly withdrew my hand from this little fur covered thing setting on top of my hair. I sort of froze up for a minute, and then decided this thing had to be removed from my head. I had to either do something or else sit there all night. I decided to do something and to do it instantly. I grabbed this thing from my head, and threw it on the floor, all in one single motion. Down on the floor went the headphone, mike and this thing, which turned out to be a large bat having a wing spread of about 20 inches. The poor headphone and mike really slammed to the floor; I thought for sure they were ruined. The bat was out cold. I picked up the phones/mike combination and listened in, whistled in the mike once and discovered it was all OK. I was back in business again. Then I said into the mike, "Who was that calling me?"—the wrong thing to say in a pile-up. Back came about 25 stations; whoever was calling me on that frequency was clobbered. I then put a little check mark beside the time and report I had already entered in the log. In the excitement I completely forgot the call sign of whatever was calling me. Sure enough when I got back home, I found a QSL card from this fellow all filled in with the proper time, date, report, etc. He mentioned I had returned to his call and that right after I had given him his report said, "Wait a minute; I've got troubles." Then when these troubles were over with he got smothered with QRM. I sent him a QSL card. I even wrote him a letter telling him what the trouble was that I had. I never did have one of those bats land on my head after that. I sort of learned to live with them from then on.

At the time I was on Aldabra, the total

population was about 20 people. There are three industries on the island—fishing, copra, and catching large sea turtles. Which is the best money producer I have no idea. Possibly it's the fishing. The fishermen are more afraid of the large groper fish than they are of sharks. It seems that these gropers sort of sneak up on the fishermen (who are in the water spearing fish), and take a chunk of meat out of him now and again. One fellow I met down there had the calf of his lower right leg completely gone from a groper bite. They told me they can usually scare a shark away by making lots of commotion in the water.

The catching of the large sea turtles was interesting work to observe. Usually three fellows go out in one of the large pirogues (boats). When a turtle is seen they row the boat near the turtle, and they throw a spear into the back of the turtle; the spear only goes into the turtle's back a few inches. The turtle is hauled into the boat, turned over on its back and then a few more are caught. When they have a good haul they come ashore and the turtles are placed in the turtle pond. The spearing of the turtle does him no harm since the spot where the spear went thru its soft back soon heals over and the turtle is as good as he ever was.

Life on Aldabra to me seemed very good; everyone had all the food they needed for I believe each one there was allowed one pound of rice per day. If they did not use their ration the owner of the island bought the rice back from them at a fair price. I saw no one beating their brains out working themselves to death. They all seemed to be sort of taking it easy. I think they are all very satisfied with their job. Of course, occasionally there is a little trouble between a few fellows, which the island manager soon clears up. There is even a small jail on the island that on occasion is occupied, but not very often. I suppose the island manager is the judge in these disputes. Life to me on Aldabra was very enjoyable; the bands were open nearly around the clock. With the sun spot count increasing each day now, I certainly would like to return to Aldabra. With even 10 meters starting to open again I bet I would have a ball. Remember when I was down there the sun spot count was near the 11 year minimum. The possibility of my returning there at this time seems to be very remote, if not impossible; but if the chance ever turns up I would like to be on again from down there. Oh, yes, if you want one of the most delicious meals in the world, try one of the Aldabra turtle steaks. They are one of the most tender steaks I have eaten.

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If you are interested in picking up sea shells by all means go to the Aldabras; they are there by the thousands just waiting for someone to pick them up. I sent Peggy two large boxes of them. I had already sent her other sea shells from other spots and she told me, "No more sea shells, please." One extra large clam fossil I found there was large enough for me to lay down in and be closed shut. We shipped this one back to Mahe to be put in their museum. The clam from that shell would have fed 30 or 40 people, I guess. Its age was estimated to be more than a thousand years old. With all the birds, fish, copra, sea shells, bats, and miles and miles of nice sandy sea coast, life there is not bad at all. All the workers there are men, so there is never any trouble with arguments over some woman.

I stayed on Aldabra Island for 17 days. I found that 17 days is by far too long to stay at one QTH as far as DXpeditioning is concerned. Give me 7 good days and everyone will be worked who really tries; after that you have to start digging for QSOs. But I was sort of stuck for those 17 days, since Jake the boat owner had the little Lua-Lua up high on the beach, painting and cleaning it up. He put it up on high dry sand when the moon was full and had to wait until there was the next extra high tide so he could float it away again. This extra long stay was not too bad, since there were many things of interest to do and to look at. Time flew by anyway.

Finally Harvey gave me a call on 20 and said for me to be ready to depart the next morning at 8:30 AM. Down came the antenna, off went the power plant, things were all wrapped up and made ready to load up the boat. I contacted the manager of the island and told him I would need the use of a pirogue the next morning with a few fellows to help me load up and row out to the Lua-Lua when it arrived. To bed I went for the first good long night's rest I had since I had arrived at Aldabra. I visited all the workers and thanked them all for their help, thanked the island manager and took one final look at the camp site. I was ready to QSY from Aldabra at 8:00 AM.

The Lua-Lua arrived at about 8:15, so out we went in the loaded pirogue. The old SE monsoon by this time had really got going and we had a heck of a time loading the equipment from the pirogue to the Lua-Lua. A number of times things nearly went overboard, until we got the swing of the way the waves were behaving. We would watch for a big swell to start our way, and yell to the fellows in the Lua-Lua to get all set; then we grabbed an armful of items and waited until the swell pushed our pirogue up high, parallel with the deck of the Lua-Lua, and in a fast swing handed items to the outstretched arms of the fellows in the Lua-Lua. This required some split second timing and fast movement on the part of the fellows on both boats. The last item to leave the pirogue was me. The pirogue departed for the beach, and we set sail for Mahe.

The seas were in a very foul mood all the way back. I finally managed to get my equipment mounted on the eating table, the old putt-putt fastened down, and I was again /MM. Quite a number of waves swept completely over the ship, and the fellows at the wheel hung on for dear life so they would not be swept overboard. What a time we had trying to shoot the sun, moon, Venus, etc., with the horizon very vague; locating the horizon was a must before any bearings could be taken. All this time I am at the radio listening to WWV or some other station with standard time signals, calling off the seconds. Both Harvey and Jake had their sextants in their hands. Eventually we would get a shot and Harvey and Jake would then go to their little desks and start trying to figure where we were! Every now and again they would actually agree on the same exact spot. One time one of them called out the answers to his shot and according to my map we would have been about 300 miles west of Cairo, Egypt, out in the Sahara Desert! He later re-figured and found that he had subtracted one of his figures instead of adding. But as a rule their figures more or less agreed. Dead reckoning helped quite a bit also. In plain English, dead reckoning means you are located at such and such a place using common sense.

The second day out from Aldabra, on the way back to Mahe, I was on the air having a FB time QSOing the boys with those breakers breaking over the boat, and bango—the sky light above my operating table was struck by an enormous wave, it was lifted up and about a bathtubfull of sea water came on top of me, the equipment, cameras and all. This brought a sudden silence to the equipment. It was silent all the rest of the way back to Mahe. I tried drying it off the best I could with what damp clothes we had on deck, but it was a long way from being dry. It took us about 10 days to battle our way back to Mahe; all this time the equipment just lay there with the salt water doing its worst to it, parts of the chassis starting to turn green when we arrived on Mahe. It did not look good to me at all; I thought for sure that I would have to get word to Ack to send me another KWM-2, but before I sent out this distress message I de-

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cided I would try overcoming this salt water trouble.

Off went the cabinet, and the scrubbing job began. After two days of hard work, it looked very nice and clean. I plugged it in, expecting the smoke to rise from somewhere. There was no smoke from it, but there were no signs of any signals from it either. Nor was there any excitation on transit. The only thing that moved was the S meter, and it moved backwards. It looked like I was in for lots more cleaning before there were going to be any signals from VQ9A. This time I really dug in. First it got the water hose treatment! Try squirting water down in those pretty little *if* transformers; you will be surprised the places it squirts out! After a few days of this cleaning, wiping, polishing, and sponging, things looked very good. This time I placed the equipment out in the hot Mahe sunshine for two days, turning the chassis over every hour; finally on the third day I placed it in the oven at the hotel, turned the heat up to 160 degrees and let it cook for 6 hours. This time I knew it was dry before I plugged it in. Still the S-meter read backwards, and a very faint hum could be heard from the phones. On PA plate current position the meter read about 15 mils. Still, no excitation. This time I was ready to send Ack that distress message for sure. After some thought I decided I would try just once more before sending this message to Ack. This time out came most of the parts, the *if* transformers inside were all green, covered with green scum and mildew. Each one was very carefully cleaned with carbon-tet; the trimmers were taken apart and I noticed the silver plating on them was starting to peel off; the power transformer was even taken apart and found to be covered with this green scum. Sometime one of you fellows might try a real cleaning job on the little band switches in modern-day equipment. This time I spent 3 full days cleaning; then back into the oven again for more baking, and then with not much hopes it was plugged in. Again the S-meter read backwards—but the receiver was operating again. Next I tried the transmitter. By golly, it worked! ! !

I was back in business again at VQ9A. I could never get the VFO to calibrate right, and when I returned the set to Collins about two years later, the S-meter was still reading backwards. They sent me a new VFO to install so the calibration difficulty was eliminated. I never did have any more trouble with the rig after that, except the usual amount of tube trouble.

. . . Gus

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S-53 Receiver	44
S-53A Receiver	49
SX-62 Receiver	125
SX-71 Receiver	89
S-76 Receiver	69
S-77A Rec (AS-IS)	25
S-86 Receiver	59
S-95 150Mc Rec	39
SX-96 Receiver	119
SX-99 Receiver	75
SX-100 Receiver	139
SX-101Mk II Rec	125
SX-101Mk III Rec	139
SX-101A Rec	199
S-108 Receiver	69
SX-111 Receiver	134
SX-115 Receiver	325
SX-117 Receiver	225
S-120 Receiver	39
SX-140 Receiver	69
CRX-2 150Mc	69
CRX-3 Aircraft	69
R-46 Speaker	8
R-46B Speaker	9
R-48 Speaker	12
HT-17 (AS-IS)	25
HT-30 Xmtr	119
HT-31 Linear	119
HT-32 Xmtr	249
HT-32B Xmtr	349
HT-33 Linear	169
HT-33A (conv to B)	269
HT-37 Xmtr	225
HT-40 Xmtr	49
HT-44 Xcvr	249
P-26 Supply	49
P-150AC Supply	75
P-150DC Supply	75
SR-160 Xcvr	189
HA-5 VFO	45
HA-6 Transverter	89
HA-10 Tuner	15

HAMMARLUND

HQ-100C Rec	$109
HQ-110 Receiver	119
HQ-110C Rec	129
HQ-110A Rec	159
HQ-120 Receiver	59
HQ-129X (AS-IS)	25
HQ-140X Rec	99
HQ-145XC Rec	169
HQ-160 Receiver	189
HQ-170 Receiver	169
HQ-170C Rec	179
HQ-170A Rec	239
HQ-170AC Rec	249
HQ-170AC with immunizer	299
HQ-180C Rec	249
SP-600JX-17 Rec	275
HX-50 Xmtr	199

HEATHKIT

HR-20 Receiver	$ 89
MT-1 Xmtr	39
MR-1 Receiver	49
DX-20 Xmtr	24
DX-35 Xmtr	29
DX-40 Xmtr	34
DX-60 Xmtr	59
DX-100 Xmtr	85
DX-100B Xmtr	99
TX-1 Transmitter	119
HX-11 Xmtr	29
HW-12 75m Xcvr	99
HW-32 20m Xcvr	89
VF-1 VFO	17
HG-10 VFO	29
HW-10 Ten'er	29
HW-10 6m Xcvr	169
VHF-1 Seneca	159
HP-20 AC Supply	25
MP-1 DC Supply	25
UT-1 AC Supply	19
HO-13 Hamscan	49
HA-14 Mob. Linear	95
HP-14 DC Supply	75
HP-24 AC Supply	50

HUNTER

2000A Linear	$325

JOHNSON

Adventurer	$ 25
Challenger	59
Viking I	49
Viking II	69
122 VFO	19
Ranger I	89
Ranger II	169
Valiant I	139
Valiant II	239
500 Xmtr	349
Pacemaker	149
Courier Linear	139
275W M'box/SWR	69
Mobile Xmtr (AS-IS)	25
Mobile VFO (AS-IS)	15

KNIGHT

R-55 Receiver	$ 39
R-55A Receiver	44
R-100 Receiver	59
R-100A Receiver	69
T-50 Transmitter	24
T-60 Transmitter	34
T-150 Transmitter	59
T-150A Xmtr	69
V-44 VFO	17
X-10 Calibrator	5

LAKESHORE

Phasemaster IIB	$149
PP-400GG Linear	99
Signal Splitter	29

LAFAYETTE

HE-30 Receiver	$ 39
HE-45 Xcvr	65
HE-45B Xcvr	75
HE-61A VFO	15
HA-90 VFO	29
KT-320 Receiver	49

LOUDENBOOMER

Mk II Linear (RF)	$125

NATIONAL

SW-54 Receiver	$ 24
NC-57 Receiver	49
NC-60 Receiver	39
NC-98 Receiver	69
NC-105 Receiver	75
NC-109 Receiver	79
NC-125 Receiver	69
NC-155 Receiver	99
NC-173 Receiver	69
NC-183 Receiver	89
NC-183D Receiver	149
NC-188 Receiver	69
NC-270 Receiver	119
NC-300 Receiver	149
NC-303 Receiver	249
VFO-62	34
XCU-300 Calibrator	5
HRO-60 Receiver	225
NTS-1 Speaker	9
NTS-3 Speaker	12
NCX-3 Xcvr	189
NCXA Supply	75
NCXD Supply	75
NCX-5 Xcvr	395
NCL-2000 Linear	425

P&H

LA-400 Linear	$ 69
LA-400B Linear	79
LA-400C Linear	89

POLYTRONICS

PC-6 6m Xcvr	$175
62B 6 & 2m Xcvr	225

RME

DB-23 Preselect	$ 25
4300 Receiver	69
4302 Speaker	9
4350 Receiver	89
4350A Receiver	99
6900 Receiver	149

SBE

SB-33 Xcvr	$175
SB-34 Xcvr	275
SB1-LA Linear	125
SB2-DCP Supply	35
SB3-DCP Supply	75

SINGER

PR-1 Panadaptor	$ 99

SONAR

20m Monobander	$ 99
AC-10 AC Supply	75
DC-10 DC Supply	75

SWAN

SW-120 Xcvr	$119
SW-140 Xcvr	119
SW-175 Xcvr	119
SW-240 Xcvr	189
SW-117AC (for 240)	65
SW-117B AC Sup	50
SW-12 DC Supply	75
SW-350 Xcvr	299
SW-117XC AC Sup	75

TMC

GPR-90 Receiver	$225
GPR-90 Speaker	19
GSB-1 Slicer	75

WATERS

Codax Keyer	$ 59

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I enclose $________; I will pay balance (if any)

☐ COD ☐ 1 year ☐ 2 years ☐ 3 years

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Shipping Clerks
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Send picture, resume, and salary requirement. .Would consider helping with moving expenses for out-of-town applicant.

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LOOK at your low Monthly Payment AFTER JUST $5.00 DOWN

350 10-80m Transceiver	(14.98)	$420.00
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Two 3-400Z Tubes for above	(2.27)	68.00
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406B Miniature Phone Band VFO	(2.52)	75.00
410 Full Coverage VFO	(3.25)	95.00
117XC 117v AC Supply w/cabinet & spkr	(3.25)	95.00
230XC As above, but for 230 volts	(3.61)	105.00
117XB 117v AC Supply only – less cabinet & spkr. (normally used with 400)	(2.52)	75.00
230XB As above, but for 230 volts	(2.88)	85.00
14-117 12v DC Supply w/cable	(4.51)	130.00
14-230 As above, but w/230v Basic sup	(4.87)	140.00
117X Basic AC Supply ONLY	(2.16)	65.00
230X Basic AC Supply ONLY	(2.52)	75.00
14X 12v DC Module & Cable	(2.16)	65.00
14XP As above, but Positive Ground	(2.34)	70.00
Cabinet, Speaker & AC Line Cord		30.00
117v or 230v Line Cord (specify)		5.00
8' Power Supply Cable w/Jones Plug		3.00
VX-1 Plug-in VOX		35.00
SSB-2 Selectable Sideband Kit for 350		18.00
22 Dual VFO Adaptor for 350 & 400		25.00
100kc Calibrator Kit for 350		19.50
500kc Calibrator Kit for 250		19.50
10m Full Coverage Kit for early 350's		15.00
55 Swantenna – Remote Control	(3.25)	95.00
45 Swantenna – Manual	(2.16)	65.00
Deluxe Mobile Mounting Kit		19.50
RC-2 Remote Control Kit		25.00

The payments shown above are for a 36-month time-payment plan with $5.00 down. The minimum total order that may be financed for 12 months is $60.00; for 24 months - $120.00; for 36 months - $180.00. NOW! Our time-payment plan offers a 105-day pay-off option!

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IMPORTANT! – Be sure to send all Mail Orders and Inquiries to our Milwaukee store, whose address is shown above. VISIT – Please do not write the following Branch stores – they are set up to handle walk-in trade only-

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6450 Milwaukee Avenue
Phone (312) 763-1030

ORLANDO, FLORIDA
19 Azalea Pk. Shpg. Ctr.
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CHICAGO & ORLANDO STORE HOURS: Mon, Wed, Thurs - 12 to 9 pm; Tues & Fri - 12 to 5:30 pm; Sat - 10 am to 4 pm

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Proprietor

GET OUR DEAL TODAY!

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I am interested in the following new equipment: ______

I have the following to trade: (what's your deal?) ______

Ship me the following New Equipment: ______

I enclose $______ I will pay balance (if any)

☐ COD ☐ 1 year ☐ 2 years ☐ 3 years

Name ______

Address ______

City ______

State ______ Zip ______

☐ **Send Reconditioned Equipment Bulletin**

WTW Country List

AC 1, 2, 5, 6, 7, 8, 9, 0—Bhutan
AC3—Sikkim
AC4—Tibett
AP—East Pakistan
AP—West Pakistan
BV, C3—Formosa (Taiwan)
BY, C—China
CE—Chile
•CE9—See KC4
CE0A—Easter Island
CE0X—San Felix
CE0Z—Juan Fernandez
CM, CO—Cuba
CN—Morroco
CP—Bolivia
CR3, 5—Portuguese Guinea
CR4—Cape Verde Islands
CR5—Principe, Sao Thome
CR6—Angola
CR7—Mozambique
CR8—Portuguese Timor
CR9—Macao
CT1—Portugal
CT2—Azores
CT3—Maderia
CX—Uruguay
DJ, DL—German Fed. Rep. West)-RFU
DL, DJ—West Berlin
DM—German Democratic Rep. (East)-RFU
DU—Phillipines
EA—Spain
EA6—Baleric Is.
EA8—Canary Is.
EA9—Ifni
EA9—Rio de Oro
EA9—Spanish Morroco
EA0—Rio Mundi & Fernando Poo Is.
EA0—Spanish Guinea
EI—Rep.of Ireland
EL—Liberia
EP—Iran
EA3, 9E3, 9F3—Ethiopia
F—France
FB8—Amsterdam & St. Paul Is.
FB8—Crozet Is.
FB8—Kerguelen Is.
FB8—French Antartica-REF
FC—Corsica
FG7—Guadeloupe
FH8—Comoroes Is.
FK8—New Caledonia
FL—French Somaliland
FM7—Martinique
FO8—Clipperton Is.
FO8—Loyalty & Chesterfield Is.-REF
FO8—Toubouai (Austrail Is.)-REF
FO8—Tuamotou (Gambier Is.)-REF
FO8—Marquessa Is.-REF
FO8—Austrail Is. (except Toubouai)-REF
FO8—Society Is. (Tahiti)-REF
FP8—St. Pierre & Miquelon
FR7—Reunion Is.
FR7/G—Glorieuses Is.
FR7/J—Juan de Nova & Europe Is.
FR7/T—Tromilen Is.
FS7—Saint Martin Is.
FU8, YJ1—New Herbides Is.
FW8—Wallis & Futuna Is.
FY7—French Guiana & Inini
G, GB—England
GC—Guernsey & Dependencies
GC—Jersey Is.
GD—Isle of Man
GI—Northern Ireland
GM—Scotland
GW—Wales
HA—Hungary
HB—Switzerland
HE, HB0—Liechtenstein
HC—Educador
HC8—Galapagos
HC8E, KX6—Ebon Atoll
HH—Haiti
HI—Dominican Rep.
HK—Colombia
HK0—Bajo Nuevo
HK0—Malpelo Is.
HK0—San Andres & Providencia Is.
HL, HM—Korea (South)
HM—Korean Peoples Rep. (North)
HP—Panama
HR—Honduras
HS—Thailand
HV—Vatican
•HZ—See 7Z
I1—Italy
IS1—Sardenia
IT1—Sicily-DARC
I1—Trieste-DARC
JA, KA—Japan
JT—Mongolia
JY—Jordan
K, W, WA, WB, etc.—USA
•KA—See JA
KB6—Baker, Howland & American Phoenix
•KC4U—Antarctica (see CE9)
KC4—Navassa Is.
KC6—Eastern Carolines
KC6—Western Carolines
KC6—Palau-NZART
•KG1—See OX
KG4—Guantanamo Bay
KG6—Guam
KG6—Marcus Is.
KG6—Mariana Is.
KG6I—Bonin & Volcano Is.
KH6—Hawaii Is.
KH6—Kure Is.
KJ6—Johnson Is.
KL7—Alaska
KM6—Midway Is.
KP4—Puerto Rica
KR6—Ryuku Is.
KS4—Swan Is.
KS4B—Serrana Bank & Rancador Cay
KS6—American Samoa
KV4—Virgin Is.
KW6—Wake Is.
KX6—Marshall Is.
KZ5—Canal Zone
LA—Norway
LA/P—Jan Mayen
LA/P—Bear Is.-DARC
LA/P—Svalbard
LH4—Bouvet Is.
LU—Argentina
LU Z—(see KC4)
LX—Luxembourg
LZ—Bulgaria
M1, 9A1—San Marino
MP4B—Bahrein Is.
MP4M, VS9—Sultanate of Muscat & Oman
MP4Q—Qatar
MP4T—Trucial Oman
OA—Peru
OD5—Lebanon
OE—Austria
OH—Finland
OH0—Aland
OK—Czechoslovakia
ON—Belgium
OR4—(see KC4)
OX, XP—Greenland
OY—Faroes
OZ—Denmark
PA0, PI1—Netherlands
PJ—Dutch West Indies
PJ2M—Sint Maarten
PX—Andorra
PY—Brazil
PY0—Fernando de Noronha
PY0—St. Peter-&-Paul Rocks
PY0—Trindade & Martim Vaz Is.
PZ—Surinam
SL, SM—Sweden
SP—Poland
ST—Sudan
SU—Egypt
SV—Greece
SV—Dodecanese Is.
SV—Crete
TA—Turkey
TA—European Turkey-DARC
TF—Iceland
TG—Guatemala
TI—Costa Rica
TI9—Cocos Is.
TI9C—Comoran Reef
TJ—Cameroun
TL—Central African Rep.
TN—Congo Rep.
TR—Gabon Rep.
TT—Chad Rep.
TU—Ivory Coast
TY—Dahomey Rep.
TZ—Mali Rep.
UA, UV, UW 1 thru 6—European Russia-RFU
UA—Russian Antartica-RFU
UA1—Franz Josefland
UA2—Kaliningradsk
UA, UW, 9, 0—Asiatic Russia
UA0—Dickson Is.-RFU
UA0—Magadan Is.-RFU
UA0—Taimar-RFU
UA0—Tuva ASSR-RFU
UA0—Chukotsk-RFU
UA0—Yakut ASSR-RFU
UA0—Sakhlin Obl.-RFU
UB5, UT5—Ukrain
UC2—White Russia
UD6—Azerbaijan
UF6—Georgia
UG6—Armenia
UH8—Turkoman
UI8—Uzbek
UJ8—Tabzhik
UL7—Kazakh
UM8—Kirghiz
UN1—Karelo-Finnish Rep.-DARC
UO5—Moldavia
UP2—Lithuania
UQ2—Latvia
UR2—Estonia
VE, VO—Canada
•VO—See VE
VK—Australia
VK—Lord Howe Is.
VK4—Willis Is.
VK9—Christmas Is.
VK9—Cocos Is.
VK9—Nauru Is.
VK9—Norfoflk Is.
VK9—Papua Territory
VK9—Territory of New Guinea
VK0—Heard Is.
VK0—Macquarie Is.
•VK0—See KC4
VP1—British Honduras
VP2—Antigua, Barbuda
VP2—Anguilla
VP2—British Virgin Is.
VP2—Dominica Is.
VP2—Grenada Is.
VP2—Monstserrat
VP2—St. Kitts and Nevis
VP2—St. Lucia
VP2—St. Vincent & Dependencies
VP3—British Guiana
•VP4—See 9Y4
VP5—Turks & Caicos
VP6—Barbados
VP7—Bahamas
•VP8—See KC4
VP8—Falkland Is.
VP8—So. Georgia
VP8—So. Orkneys
VP8—So. Sandwich Is.
VP8—So. Shetlands
VP—Bermuda
VQ1—Zanzibar
VQ8—Agalega & St. Brandon
VQ8—Chagos
VQ8—Mauritius
VQ8—Rodriguez Is.
VQ9—Aldabra Is.
VQ9—Seychelles
VQ9—Desroches
VQ9—Farquahar Is.
VR1—British Phoenix Is.
VR1—Gilbert, Elis, & Ocean Is.
VR2—Fiji
VR3—Fanning & Christmas Is.
VR4—Solomon Is.
VR5—Tonga Is.
VR6—Pitcairn Is.
VS5—Brunei
VS6—Hong Kong
VS9—Aden & Socotra
VS9H—Kuria Mauria Is.
VS9K—Kamaran Is.
VS9M—Maldive Is.
VU2—Andaman & Nicobar Is.
VU2—India
VU2—Laccadive Is.
•W—See K
XE, XF—Mexico
XE, XF—Revilla Gigado
XT—Voltaic Rep.
XU—Cambodia
XV—South Viet Nam-RFU
XW8—Laos
XZ2—Burma
YA—Afghanistan
YI—Iraq
TK—Syria
YN—Nicaragua
YO—Rumania
YS—Salvador
YU—Yugoslavia
YV—Venezuela
YV0—Aves Is.
ZA—Albania
ZB2—Gibraltar
ZD3—Gambia
ZD5—Swaziland
ZD7—St. Helena
ZD8—Ascension
ZD9—Gough & Tristan de Cunha

ZE—Rhodesia
ZF1—Cayman Is.
ZK1—Cook Is.
ZK1—Manihiki Is.
ZK2—Niue Is.
ZL—Auckland & Campbell Is.
ZL—Chatham Is.
ZL—Kermidac Is.
ZL—New Zealand
*ZL5—See KC4
ZM6—Western Samoa
ZM7—Tokalaus Is.
ZP—Paraguay
ZS1, 2, 4, 5, 6—South Africa
ZS2—Marion & Prince Edward Is.
ZS3—South West Africa
ZS7—Swaziland
ZS8—Basutoland
ZS9—Bechuanaland
1M4—Maria Teresa
1S9—Spratley Is.
3A—Monaco
3V8—Tunisia
3W8—North Viet Nam-RFU
4S7—Ceylon
4U—I.T.U. Geneva, Switzerland
4W—Yeman
4X—Israel
4X1—Israel/Jordan Demilitarized Zone
5A—Libya
5B4 ZC4—Cyprus
5H3—Tanganyika
5N2—Nigeria
5R8—Malagasy
5T—Maurantania Rep.
5U7—Niger Rep.
5V—Togo Rep.
*5W1—See ZM6
5X5—Uganda
5Z4—Kenya
6O—Somali Rep.
6W8—Senegal
6Y5—Jamaica
7G1—Rep. of Guinea
7Q7—Malawi Rep.
7X—Algeria
7Z(HZ)—Saudi Arabia
8F—Indonesia
8Z4—Saudi Arabia/Iraq Neutral Zone
8Z5, 9K3—Kuwait/Saudi Arabia Neutral Zone
*9A1—See M1
*9E, 9F—See ET
9G1—Ghana
9H1—Malta
9J2—Zambia
9K2—Kuwait
*9K3—See 8Z5
9L1—Sierra Leone
9M2—West Malaysia
9M6, 8—East Malaysia
9M4—Singapore
9N1—Nepal
9Q5—Rep. of the Congo
9U5—Burundi
9X5—Rwanda
9Y4 (VP4)—Trinidad and Tobago

All countries are from ARRL list except those marked with one of he following:
DARC—Deutscher Amateur Radio Club (West Germany)
NZART—New Zealand Association of Radio Transmitters
REF—Réseau des Emetteurs Francais (France)
RFU—Radiosport Federation off the USSR
The asterisks indicate additional prefixes for a country.

Gus Browning W4BPD
c/o 73 Magazine
Peterborough, N.H.

The WTW and You, Mr. DX'er

The Fall DX Season is upon us again. This is the time of year when the DX will be coming thru with those strong signals. With the sun spots getting a little bit more plentiful every month, DX'ing will be FB for a good many years now. After that the spots will taper off and we all will be getting older and older. By the time the next peak comes around some of us won't be here to enjoy the FB DX'ing that can and will probably take place again. Or by that time the frequency allocation conference will have taken place, and maybe our bands will all be stolen from us by the commercials or other folks that are eyeing them right now. So I say if you are interested in working DX, now is the time to get started. Get in on the fun while the bands are jumping with plenty of DX.

Of course if you are stuck with the ARRL's DXCC you have had it! You have just "worked yourself out of business" if you have been with the DXCC all these years. There just isn't anything on the bands that you need, so you can put a cover over your rig and go take a look at TV or go fishing. But there is a solution to your problems in the WTW. To qualify in the WTW competition all QSO's have to have taken place since 0001 GMT May 1, 1966. Now this puts lots of countries in the "rare" side of your ledger. I would estimate that well over 100 countries have not been on the air since May first. Is that not better than having maybe just one or two rare ones left like the DXCC? At least you have some DX'ing to do and that's better than 75 meter ragchewing or traffic handling. There is plenty for you to do if you like to work DX for the all new WTW DX award. Remember there are certificates for 100, 200, 300 and 350 countries, as well as a WTW for each band, and each mode. There is no mixing of the two or the bands, either. Everyone starts at the same point. The newcomers to DX'ing have the same chance as the old time DX'er.

Our country list is a reasonable list. It's made up of all the countries on ARRL's DXCC list plus a few that the Radiosport Federation of the USSR recognizes and a few others from the REF of France and the NZART. Others will be added when we hear from the other nationally recognized amateur societies of overseas nations. We are not including any countries just because we think they should be in the WTW list. All countries were suggested by others, not us. We don't want anyone to "button hole" us at some convention or gathering and ask us why such and such a place is a country, and such and such is not.

Of course if you are a tired, lazy, washed-out DX'er, the WTW is not for you. It's for the wide-awake fellow who wants to do something, one who is tired of just sitting in his shack twiddling his thumbs with nothing to do but gaze at his rig and yawn and go out to that TV set and gaze at it. You just keep on with the DXCC. It's your meat. The top fellows in the DXCC have nothing much to look forward to. Of course, they may need ZA or YI or maybe one or two others and with all the weekly DX bulletins you know if any of these will be on well in advance so there is absolutely nothing for you to do. The days of call mode and band

name

address number of countries

List of stations worked (with date of QSO) in alphabetical order. This list can extend to the back of the card.

On the reverse: Name, call and signature of person submitting or verifying cards and date.

Please use this format (shown full size) for submitting applications for WTW award. Send to Gus, 73 Magazine, Peterborough, NH 03458.

"sneaking home" from work like back in the 50's has gone as far as the DXCC is concerned. But this can be done right now with the WTW. The WTW will bring back the "good old days" for all of you, even the newcomers. There is plenty of real good stuff on for the serious minded WTW DX'er—but not for the top boys in the DXCC. The DXCC certainly was a good deal for the boys a few years ago, but, fellows, those days are gone. This WTW is a modern-day DX'er's wish come true. Get in there fellows and join in on the fun. It's waiting there just for you.

We are gradually getting "verification clubs" lined up for the awards. We don't want any one to have to mail his QSL cards away from his continent, and in the case of USA hams we want to have a "verification club" in each call area. We still need a few to fill in here and there and are looking for volunteers yet in a few places. Any of you club members in the areas not yet covered, how about taking this up at your next club meeting and submit your club for consideration to me, c/o 73 Magazine. No individuals please—only recognized clubs. Here is a full break down on how we now stand:

Asia—We yet need one here
Africa—Also still needed
Oceania—Also needed
Europe—Via RSGB
South America—Venezuelano Radio Club, Caracas
Canada—Edmonton Radio Club
W/K1—Still needed.
W/K2—Still needed.
W/K3—Still needed
W/K4—Virginia DX Century Club (W4NJF)
W/K5—Still needed
W/K6—Orange County DX Club (W6KTE)
W/K7—Western Washington Radio Club (W7PHO)
W/K8—Still needed.
W/K9—Still needed.
W/K0—Still needed.

We ask all verification clubs and hams to use a uniform method of submitting to me the information on the DX'ers who qualify. Please use the form shown. This will make my task a lot easier and we all will be using the same system of keeping records. I strongly suggest you keep a similar list on filing cards for future reference if needed. Note to verifying clubs: Be sure to return the cards to the sender, fellows. We don't want anyone accusing us of slow service, lost cards, stolen cards, and other type things that I have heard about some other awards that require QSL cards. Let's all really give the DX'ers fast service and no monkey business.

Will close this little article with a reminder: I shortly will start putting out a weekly DX magazine, The DX'ers Magazine. It'll help you keep right up to the minute on current active DX. Most of the good DX is past history by the time it's in a monthly magazine, you know. This is something entirely different—something that no monthly magazine can do. Let me hear from you. . . . Gus

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Hammarlund HQ-100C	129.00	109.00
Hammarlund HQ-110C	149.00	129.00
Hammarlund HQ-170C	259.00	199.00
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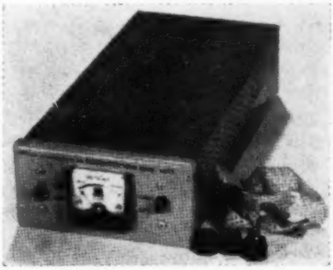

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The Future of the 10 meter Band

The text of a talk given May 14 by 73's propagation columnist to the North Jersey DX Association.

About the 10th of April, 1966 I received a telephone call from Mr. Bob Stankus W2VCZ. He asked me in a very casual manner, as if there were nothing to it, if I would predict for the North Jersey DX Association the future of the 10 meter band. I did some quick thinking and realized immediately that in order to predict the future of the 10 meter band I also had to predict the future of the present sunspot cycle. I do not like to predict the sunspot cycle because after 20 years research on sunspots I have come to realize how whimsically the sun can behave. I also know from history that some pretty important astronomers and researchers had gotten into trouble working on this subject in the past—many of them knowing far more about the subject than I do. However, I considered the subject as a challenge and decided to see what I could come up with. I had quite a bit of data available on past sunspot cycles to use as research material.

First, I went into the history of frequencies near the 10 meter band in the archives of the RCA Frequency Bureau and found that RCA Communications started to experiment with 31 MHz which is of course slightly less than 10 meters, early in 1930. The experiments were conducted with Buenos Aires. RCAC using W2XS on 31420 KHz and Buenos Aires using LQB2 on approximately the same frequency. Unfortunately this was near the beginning of the 1930 sunspot low and the project had to be suspended until we got into the area of high sunspot numbers between 1936 and 1938. These frequencies were then run simultaneously with normal communications frequencies, which were on about 21 MHz and received on a dual tape recorder so that the messages that Buenos Aires was sending would appear, one above the other, on the same piece of wide tape. As an experiment the operators were ordered to copy the higher frequency whenever it was useful even though the lower frequency was still satisfactory. I further found in the archives of the Frequency Bureau that the amateurs were allocated the 28 to 30 MHz band in 1927 for experimental purposes according to the records of the Madrid Conference in 1932. So the amateur preceded the commercial stations in the investigation of this band. They proved its usefulness.

Since the early 1950's the receiving technicians at the RCA Communications receiving station at Riverhead Long Island have kept meticulous "two hour" records of the lowest and highest frequency readable from the European area. At the same time, they also record the quality of the signals in this band. I went through these records for the years 1955 to 1960 inclusive and determined the number of hours per day throughout the whole of each year that frequencies between 26 and 30 MHz were recorded as good. The data shown by these records is presented in chart A.

An examination of this chart shows quite

	1955		1956		1957		1958		1959		1960	
	A	B	A	B	A	B	A	B	A	B	A	B
Jan	0	20	4	70	134	152	234	202	208	217	76	139
Feb	0	21	0	123	94	117	148	165	172	143	88	103
Mar	0	5	4	116	72	167	106	191	186	186	80	103
Apr	0	11	0	105	14	175	24	196	42	163	4	120
May	0	29	NR	136	0	165	8	175	0	172	16	119
June	0	33	0	117	0	205	14	171	0	169	4	109
July	0	26	0	128	0	194	0	191	0	149	0	119
Aug	0	40	0	171	4	163	8	200	0	198	0	131
Sept	0	41	40	182	88	244	84	201	12	145	10	125
Oct	0	59	NR	161	122	263	220	181	48	111	8	81
Nov	0	90	146	203	212	207	230	152	44	124	38	87
Dec	0	77	172	185	194	233	184	187	66	125	34	83
TOTAL	0	452	366	1697	934	2285	1260	2212	778	1902	358	1319

A—The number of hours between 8 AM and 2 PM EST (1300 GMT and 1900 GMT) that frequencies between 26 MHz, and 30 MHz were logged as good from Central Europe at the Riverhead, Long Island, New York receiving station of RCA Communications, Inc.
B—The Zuerich monthly sunspot number.

Chart A. Comparison of sunspot numbers with stations received on 10 meters. Compiled by J. H. Nelson of RCA Communications, Inc.

dramatically the good correlation there is between the hours of usefulness of these higher frequencies and the yearly sunspot number. In 1955, with a yearly sunspot number of only 452, Riverhead logged no hours of usefulness on frequencies above 26 MHz. I would like to point out however that this does not mean that these frequencies did not break through occasionally since the technician does not keep a constant watch for them. He inspects the band every two hours on the hour. As we go into 1956, the yearly sunspot number increased to 1697 and the hours of usefulness rose to 366. In 1957 yearly sunspot numbers rose to 2285 and the hours of usefulness increased to 934. In 1958 the sunspot number stayed above 2000 being 2212 and the hours of usefulness increased to 1260. In 1959 the sunspot numbers began to drop showing a yearly number of 1902 and the useful hours of these frequencies dropped to 778. In 1960 the sunspot number dropped to 1319 and the hours of usefulness on these frequencies dropped to 358. In 1961 we find that these frequencies did not show up in the records at all although as I have said before there were probably occasional periods where they would have been heard if we maintained constant coverage.

I would also like to point out that these frequencies have very little or no usefulness during the summer months. They begin to show up in September and fade out in April. The data shows this very clearly.

The sunspot numbers that are shown here are the monthly averages. When these averages are smoothed into 12 month smoothed averages we find that the smoothed curve began with 14 in January 1955 and increased to 81 by the end of the year. In 1956 it began with 89 and ended with 164. In 1957 it began with 170 and ended with 200. In 1958 it began with 199 and ended with 180. In 1959 it began with 179 and ended with 132. In 1960 it began with 129 and ended with 84.

It appears that a smooth sunspot number in the neighborhood of 80 to 100 is necessary before these frequencies come to life. Data on this phase of the subject appears in Chart B.

Data on this chart pertains to sunspot numbers and sunspot cycles from 1755 up to 1964. It was analyzed in the following method in an effort to produce a technique whereby it might be possible to anticipate the trend of cycle number 20 which started in 1964.

Cycle	Low Year	A	B	High Year
1	1755	19	87	1761
2	1766	7	116	1769
3	1775	12	158	1778
4	1784	9	141	1788
5	1798	37	49	1805
6	1810	64	48	1816
7	1823	44	71	1829
8	1834	16	146	1837
9	1843	9	132	1848
10	1856	23	98	1860

Cycle	Low Year	A	B	High Year
11	1867	14	140	1870
12	1878	33	75	1883
13	1889	37	86	1893
14	1901	33	64	1906
15	1913	45	105	1917 (Short Peak)
16	1923	18	78	1928
17	1933	23	120	1937
18	1944	8	150	1947
19	1954	17	200	1957
20	1964	10	(135)	(1968)
Total		468	2064	
Average		24	108	

A—The number of months with a sunspot number of 10 or less during each low period.
B—The maximum smoothed sunspot number of the following high period.

	C	D	E	F	G	H
	19	87			37	49
	7	116	7	116	64	48
	12	158	12	158	44	71
	9	141	9	141	23	98
	16	146			33	75
	9	132	9	132	37	86
	14	140			33	64
	18	78			45	105
	8	150	8	150	23	120
	17	200				
Total	129	1348	45	697	339	716
Average	12.9	134.8	9	139.4	37.5	79.4

C—The low periods with 20 or less in column A.
D—The sunspot number in column B.
E—The low periods with 12 or less in column A.
F—The sunspot number in column B.
G—The low periods with more than 20 in column A.
H—The sunspot number in column B.

Chart B. Compiled by J. H. Nelson of RCA Communications, Inc.

I analyzed the sunspot records by several different methods before I came up with what is shown in this chart. Examination of past sunspot cycles indicated that low maximums were preceded by *prolonged periods of low minimums* and high sunspot maximums were preceded by *short minimums*.

After several different attempts I found that if I counted the number of months with a sunspot number of 10 or less during each minimum period I got the best correlation indicative of what the following high was going to be like. I won't go through this chart item by item but I would like to point out to you that in Column A we have listed the number of months that 10, or less than 10, sunspots were recorded, and in Column B is shown the maximum *smooth sunspot number* for the high period that *followed a few years later*. These data show quite clearly that the higher maxima were preceded by short low periods, and the low maxima were preceded by long low periods. This will become apparent to you when you study the chart closely.

On the lower section of the chart under Column C I have listed all the low periods that had *less than 20 months* duration and in

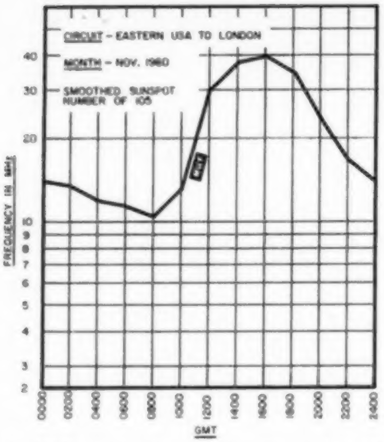

Fig. 1. MUF versus time of day, November 1960.

Column D I have listed the sunspot maximum associated with each of these periods. You will note that out of the 10 periods listed that had relatively short minima there were 8 with fairly high sunspot numbers during the following maxima.

In Column E I have been even more selective and picked out the periods that showed only 12 or less in Column A and here you see at a glance that these shortest periods of minima were followed by quite high maxima. The average lengths in months of these shorter periods was 9 months and the average sunspot maxima comes out to be 139.

If you would refer to the top of the chart and pick out cycle 20 you will see that Column A carriers the figure of 10 indicating that the 1964 low had 10 months with a sunspot number of 10 or less. A figure of 10 in Column A predicts a following maximum in the neighborhood of 135. This analytical technique therefore predicts that the sunspot number in 1968 or 1969 will reach a smooth sunspot number of at least 135 which should open the 10 meter band to Europe quite well from September to April.

Column G and H indicates that prolonged minimums were followed by low maximums. You can see from the data that when the average length of a minimum was 37.5 months, the average of the following sunspot maximum was only 79.4. Of the 9 items listed in Column G, seven of these items correctly predicted that a low maximum would follow. Two items were in error but not seriously.

To recapitulate, if we were to bet on a sunspot number to be high using the figures in Column C we would have been right 8 times out of 10. It we bet that a sunspot maximum was going to be low we would have been right 7 times out of 9 according to the figures in Column G. This particular approach indicates a strong probability that the figure associated with cycle 20 stands an 80% chance of being correct. But let me point out once again to you that I am not an expert in statistical analysis and this coupled with the fact that sunspot cycles are very difficult to predict causes me to warn you that I might be in error.

I have prepared two graphs that can be used as a further guide in anticipating the future. This first graph (**Fig. 1**) shows the type of MUF curve associated with a smoothed sunspot number of 105. It is for a circuit between Eastern U.S. and England. It can be seen from this graph that the most likely periods of the day for 10 meters (or 28 MHz) to be in operation are between 12 and 19 GMT in November. The next graph (**Fig. 2**) shows the November MUF for the same radio circuit based on a smoothed sunspot number of only 65. You will notice that this lower smoothed number predicted a MUF barely above 30 MHz. This indicates that somewhere between a smoothed number of 65 and 105 the 10 meter band is going to become operational. This figure is probably close to a smoothed sunspot number of 80 which should appear during the 1966-67 winter.

The statistics presented and analyzed in this report predict that 10 meters should come to life, at least spasmodically, between U.S.A. and Europe during the coming winter (1966-67) and should be well established by the following winter. . . . Nelson

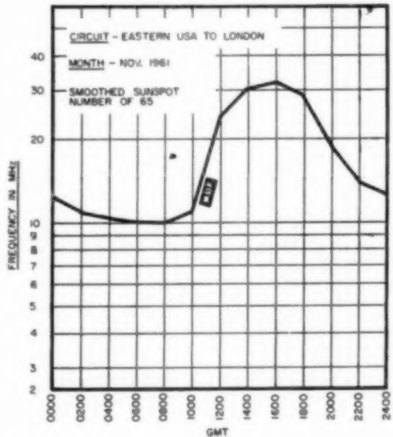

Fig. 2. MUF versus time of day, November 1961.

SWAN PRODUCTS AREN'T PERFECT!

Over a year has elapsed since I first enthused over the Swan 350 and 400. So ecstatic was I in extolling their virtues that I began composing idioms which expressed their value in comparison with brand X or Y. I had even come up with a quotient of value (frequency coverage times power divided into dollars). Oh—I felt I had something and so I called Herb Johnson, founder and owner of Swan, to see how he'd react to my "baby." While reading it to him I emphasized certain phrases and words—expecting him to say—"that's right or fine"—When I was all through there was a deathly silence. No comment—no voice at all—"Are *you* still there Herb, I asked"? And after a further pause Herb's low voice saying, "I don't like what you've written—I'd rather you didn't print it. Our gear isn't perfect—we have had our troubles and we're a long way from being satisfied, etc., etc.".

I felt disappointed—yes—but when I stopped to ponder Herb's remarks I realized only too well that he was right and therein lies my message about Swan—*the continuous improvements* which you never see listed in any ad nor in any instruction manual and which make a fine set still better.

Example: When the 350 was first produced it drifted a little too much—Swan found that they could reduce the drift 3 to 1 by physically isolating the transistorized oscillator in a little box under the chassis.

Example: It was found by using ceramic forms in the VFO—a further 6 to 1 improvement resulted.

Example: By winding their tank on a ceramic form they reduced the possibility of tuneup warmth melting or changing the shape of the original air wound coil.

Example: By changing the tuneup procedures with a simple circuit change you no longer have to worry about exceeding the dissipation ratings of the final—even for as long as several minutes.

Example: The 10 meter band is complete now; earlier models covered only part of the range.

I could go on and on—because this list isn't complete—The Swan 350 isn't perfect, but it's constantly being improved and for those who own an early version, the factory will up date yours at a very modest charge. Show me a better set and I'll eat that proverbial hat.

And for you fellows who want to know where the word "Swan" comes from—I'll tell you. Herb Johnson's father's name was Sven, Swedish for Swan.

73

Herb Gordon W1IBY

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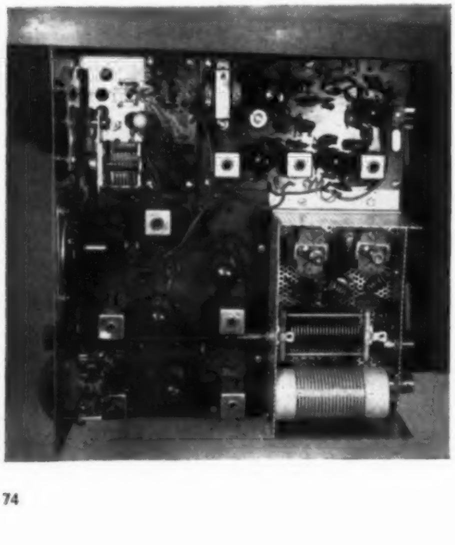
WRL Duo-Bander 84

For a long time I have been spoiled by using a transceiver in the car and the boat, to the point where the transceiver was always being taken into the house. The separate transmitter and receiver were such that it was impossible to make into a transceiver combination. When World Radio Labs announced the Duobander 84 at its low price this seemed to be an ideal way to eliminate taking the rig out of the car and hauling it into the house or, if it was on the boat, hauling the set and the AC power supply from the boat to the car and then into the house.



The specs in the ad seemed too good to believe for the money (only $159.95), but one was ordered. It is sometimes more fun to order and wait, than to buy off the shelf. This way you get double pleasure; first, the placing of the order, then the anticipation while waiting for it to arrive.

As soon as it arrived it had to be put on the air and, in spite of a large card on top of the set saying "please read the instructions before you send it up in smoke," I had to hook it up and see how the receiver worked. 80 meters was tried first, and the velvet-smooth dial and the wide 2 kHz divisions were a real pleasure to use.

The urge to transmit was great, but I decided at this point that I was not as smart as the book—so the instructions were followed, and it was on the air in a few minutes. The tuneup was the ultimate of simplicity: Adjust the bias; tune; null the carrier and set the mic gain (with the aid of the large edge reading meter); then go. The 300 watts PEP sure looked big on the monitor scope and from the reports it looked big on the other fellow's S-meter.

The next step was to start studying the instruction book to see where all this signal was coming from and how it was being produced. At the same time the top and bottom of the set were removed for a good look inside. The first impression was that here was a very nice piece of workmanship, a layout that would be easy to service, and that all the parts were first line quality merchandise; no skimping here.

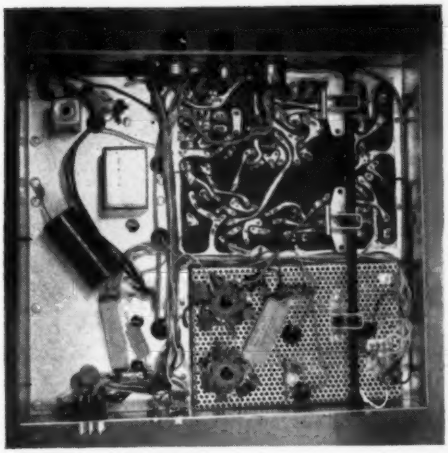
The study of the instruction manual revealed that there were seven transistors, nine tubes and four diodes. An interesting thing here is that two of the diodes are actually transistors and are being used just like K9VXL says to do in the July 1966 issue of 73 Magazine. All of the transistors are the same type, so if you like to have spares you only need one.

As is standard with any sideband equipment, this transceiver is of the mixing type. The choice of frequencies is a good one. First the turnable oscillator is quite low (1.55 MHz to 1.75 MHz) which, with the use of transistors, makes a very stable oscillator. Now since this is a set that works on 75 and 40 meters, it can quickly be seen that the right choice of *if* frequency would allow the oscillator frequency to be added to get on 40 meters and subtracted on 75 meters. The *if* frequency is 5.5 MHz. The use of a McCoy 4 crystal lattice filter gives the desired selectivity and unwanted sideband rejection.

A very clever band switching arrangement has been worked out using slide switches. A bar with fingers moves the three slide switches from 75 to 40 meters. This method of switching allows very short leads, and then there is a space savings.

Since this transceiver only tunes 200 kHz, the band pass tuning coils are slightly broadbanded so that they do not need to be tuned when going from one end of the band to the other. The coils are shunted with resistors and a portion of the coil is shorted out when going to 40 meters. Each stage has two coils so that the band pass can be fairly wide with steep enough sides to eliminate harmonics and spurious radiation.

One thing that impressed me was the fact that the parts list showed prices. This in itself is not so special, but here all the prices are shown even for special items—and the prices are net and not inflated prices. These prices are the same that you would pay in any radio store. And the prices of the special items like



The final amplifier uses a pair of 6HF5's. These tubes have a very high plate dissipation to start with, and Sylvania tells us that in amateur service they can be up-graded 30% to a total of 36 watts. These tubes also have the advantage that they will handle a fantastic amount of current because of the design of the plates. If you check the tube manual you will find that these tubes will handle 900 volts at an average cathode current of 315 mA which comes out over 280 watts each, so they just loaf along with only 300 watts PEP on two of them.

To really find out what this new transceiver was doing, Ray Abair K8NBQ and I took it over to Rowe Industries to check it out with all the nice test gear that they have. Here is what we found, using a single tone signal at 2000 Hz:

Transmitter:	
Power output	160 watts PEP
Carrier suppression	43 dB below peak output
Unwanted sideband	41 dB below peak output
spurious output (2 tone sig.)	29 dB below peak output
Oscillator drift	Negligible
Receiver:	
Sensitivity	0.45 μV for 10 dB S/N
Selectivity	2.7 kHz at 6 dB down 6 kHz at 60 dB down
Image & *if* rejection:	43 dB

The picture shows the small size of this transceiver which should make it a swell rig for mobile work. The small size will allow it to fit into the car in several ways. Dollar for dollar, you will have to look a long way to find so much transceiver for under $160; and it comes ready to operate. Just a little over 50¢ a watt.

. . . W8QUR

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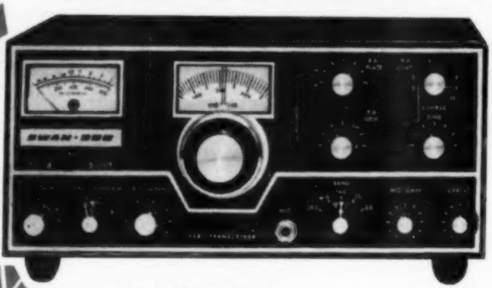

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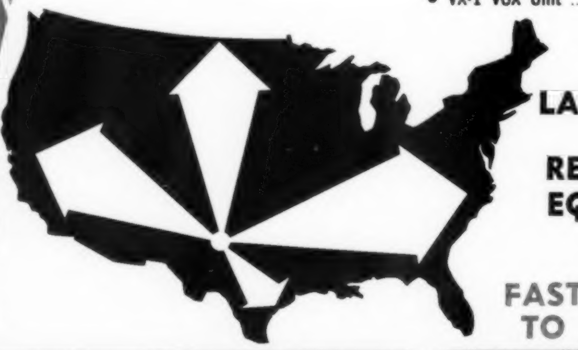

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The RF Discriminator

Here are some useful applications for a little-known circuit.

The rf discriminator is potentially one of the most useful of receiving accessories. Unfortunately, its use among hams, other than in an occasional VHF-FM receiver, is rare. This may be due to the lack of information available in amateur publications on the possibilities offered by this device. Some of these applications as a receiving aid for modes other than FM will be discussed here. Rather than go into details of operation or construction, which are adequately covered elsewhere, [1, 2, 3] this article will be concerned only with some of the wide variety of applications to which a discriminator can be adapted.

Perhaps the greatest use of this circuit is as a "locking" device to keep a station centered in the receiver passband. **Fig. 1** is a block diagram for this application. With the VFO tuned so that a signal is centered, the discriminator output is zero. If either the VFO or the applied rf signal tends to drift, the discriminator output applies a correction voltage to the VFO (which must be equipped with a varactor or similar electronic tuning capability) which tends to correct for the drift. The extent to which the correction is made depends on the slope of the discriminator characteristic and the sensitivity of the VFO. Specifically:

$$\Delta f_2 = \Delta f_1/(1 + KA)$$

where: Δf_1 is the change in rf frequency applied

Δf_2 is the resulting change at the *if* frequency

K is the slope of the discriminator characteristic in volts/kHz

A is the electronic tuning sensitivity of the VFO in kHz/volts

Fig. 2 is the circuit of the limiter-discriminator (designed by WA6BLX) in use here. The two stages of gain preceding the output stage insure that V_4 runs completely drive-saturated class C, and thus is AM-insensitive. The measured limiting threshold of this circuit is about 10 mV. With the transformer and voltages shown, the measured slope of the output curve is 2.4 volts/kHz. The dc varactor voltage must be sufficient to insure that the varactor is always reverse biased and both that voltage and the plate voltage must be well regulated, since either will modulate the output. S_1 allows the voltage fed to the varactor to be filtered to any degree desired independently of the other outputs.

Fig. 3 shows the common way to provide for varactor frequency modulation of an oscillator. It is far less cumbersome than a reactance-tube modulator and has the capability of far higher deviation sensitivity. The exact sensitivity can be varied by varying the bias voltage, the coupling capacitance C_c, or the varactor.[4] The particular circuit in use at K7DEP has a sensitivity of about 10 kHz/volt at 3 volts bias and this figure will be used in the examples below.

In its most basic application, this circuit is a very good NBFM detector. Running open loop (S_2 in **Fig. 1** open) it will give 2 volts rms audio for a 1.5 kHz deviation.

In the VHF bands, wide-band FM does enjoy some deserved popularity: Modulation is a low-level process, signal generation is easier than for SSB, and all amplifier stages run at class C efficiency. The problem is reception, which requires a wide *if* bandwidth and wide discriminator. If, however, we close the loop

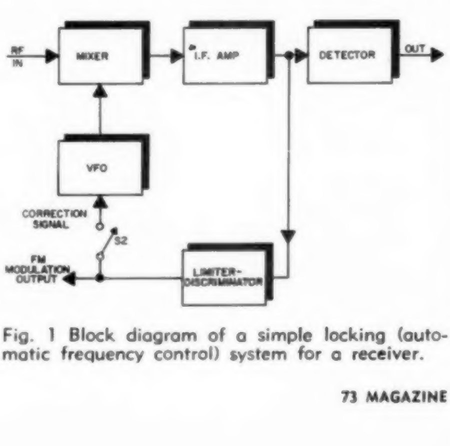

Fig. 1 Block diagram of a simple locking (automatic frequency control) system for a receiver.

with a correction signal which will follow the instantaneous carrier frequency, the modulation will be effectively narrowed by the factor 1/(K + KA) as calculated above (about 25 for the circuit discussed). Thus a 12.5 kHz deviation FM signal is reduced to 0.5 kHz in the *if* strip and to about 0.3 volts rms of audio at the FM output. Also, since the discriminator is dc coupled to the varactor, any long-term drift of either receiver or carrier will be reduced by the same factor as the modulation. Note that the same discriminator performs all three functions of bandwidth reduction, frequency locking, and detection simultaneously.

The problem of carrier and local oscillator stability becomes more serious as frequency increases. This is especially true of receivers which tune entire VHF bands in one pass. With a 10-15 kHz bandwidth, a little drift isn't too noticeable, but with a 500 Hz CW filter it can be disastrous! By running closed loop, we can easily reduce the drift to almost any degree desired. By employing a very long time constant in the correction signal path, loss of lock between CW characters can be avoided. All this allows the use of near-optimum *if* bandwidths for AM, CW, and, as we shall see, possibly even SSB.

For the serious VHF'er for whom stability is no problem, the discriminator offers an added bonus in measuring doppler shifts. By running open loop and monitoring the dc output on a VTVM (or better still on a chart recorder) 30 Hz of carrier shift can easily be read. Since observed shifts on OSCAR have been of the order of 6 kHz, this is adequate for most work. If a chart recorder having a dc offset capability is used, then even greater sensitivity is possible.

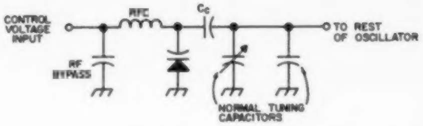
CONTROL VOLTAGE INPUT
RFC
Cc
RF BYPASS
TO REST OF OSCILLATOR
NORMAL TUNING CAPACITORS

Fig. 2. The limiter-discriminator designed by WA6BLX used by K7DEP. It will keep your receiver tuned to the station you're working even though the other station drifts slightly across the band.

In a completely different field of interest, the rf discriminator provides one of the easier, though admittedly not one of the best, ways of receiving RTTY. Running open loop, the discriminator in **Fig. 2** puts out just over two volts difference in dc level from space to mark with standard 850 Hz shift. This could be used to drive a keying tube directly or, for better reliability, used to switch a Schmitt trigger[5], and that in turn could drive a keyer in the machine local loop. A very simple arrangement of this type could be a realistic answer to the casual RTTY operator who doesn't want to invest the time it takes to build a complete audio converter-terminal unit. Incidentally, if a single VFO is used for receiving and transmitting, as is becoming increasingly common today, then that varactor is already there for FSK transmission, requiring less than 0.1 volts drive for 850 Hz shift.

Another possible use for the discriminator, and the one where it is needed most, is as a SSB tuning aid. With one of the better receivers now on the market, it is relatively easy

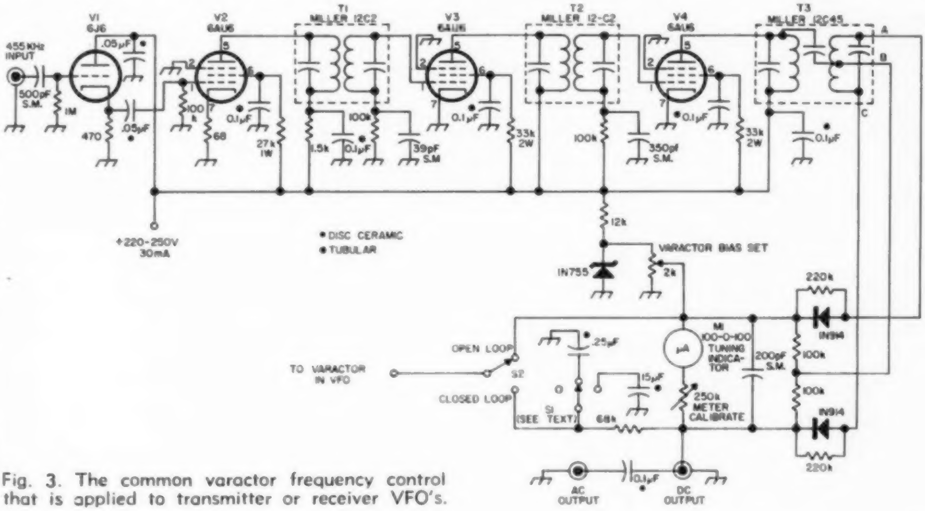
455 KHz INPUT
500pF S.M.
1M
V1 6J6
.05μF
470
.05μF
V2 6AU6
100k
68
0.1μF
27k 1W
T1 MILLER 12C2
1.5k
0.1μF
100k
39pF S.M.
V3 6AU6
0.1μF
33k 2W
T2 MILLER 12-C2
100k
350pf S.M.
V4 6AU6
0.1μF
33k 2W
T3 MILLER 12C45
0.1μF
A
B
C
+220-250V 30mA
• DISC CERAMIC
• TUBULAR
12k
IN755
VARACTOR BIAS SET
2k
220k
IN914
100k
100k
IN914
220k
M1 100-0-100 TUNING INDICATOR
μA
200pF S.M.
250k METER CALIBRATE
OPEN LOOP
CLOSED LOOP
S2
TO VARACTOR IN VFO
.25μF
15μF
S1 (SEE TEXT)
68k
0.1μF
AC OUTPUT
DC OUTPUT

Fig. 3. The common varactor frequency control that is applied to transmitter or receiver VFO's.

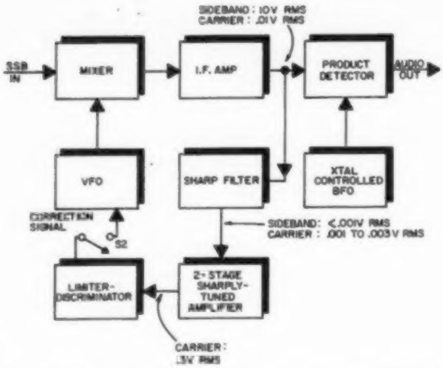

Fig. 4. Correction system to keep SSB stations tuned in properly. This is especially nice in round tables.

to tune sideband to readable fidelity. But for truly natural sounding speech, the reinserted carrier must be within 10 Hz of the suppressed carrier.[6] Not only is this difficult, but with more than two stations in the QSO, it requires constant BFO juggling.

The system in common commercial use separates the suppressed carrier from its sideband and re-amplifies it to a usable level. Then it is fed to the discriminator which provides a correction signal to the VFO to "lock" the receiver on the carrier as described above. All this will require two additional components besides the basic limiter-discriminator. The first is a sharp filter detuned slightly from the *if* center frequency (assuming that the sideband is centered), and the second is some additional amplification between the filter and limiter stages. More specifically, if we assume that the received carrier is 60 dB below the average sideband level at the *if* output (this may seem pessimistic, but remember that the carrier may be part way down the skirt of the *if* characteristic), then the sharp filter should be at least 60 dB down at twice the lowest audio frequency transmitted (usually 300 Hz). The additional amplification is to elevate the carrier to well over the limiting threshold. Two stages of gain should be sufficient. **Fig. 4** shows this process. Since the only critical component is the sharp filter, this system is quite feasible for ham use. Using this mode of operation, several stations in a single QSO will all lock if they are within ± 250 Hz. Also, since 10 Hz is below the limit of most receiver audio systems, easy exalted carrier reception of AM is provided for under the same conditions as SSB, but without the necessity of the extra amplification and filtering.

A lot of fuss and bother that isn't really necessary? Perhaps, but that is what makes the difference between "good enough for amateur" and truly professional quality.

. . . K7DEP

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[1] "Specialized Communications Systems," **ARRL Handbook**, 1961, p. 329-330.

[2] Allen Katz, "UHF Roundup," **CQ** (April, 1964), 79-80.

[3] Ralph W. Burhans, "An IF Tracking Filter for Weak-Signal Reception," **QST** (September, 1964) 11-17, 166.

[4] R. E. Baird, "Something New in Frequency Modulation," **73**, (October, 1960), 10-11.

[5] Jim Kyle, "Understanding the Schmitt Trigger Circuit," **73**, (March, 1965) 74-78.

[6] Terman, Frederick E., **Electronic and Radio Engineering**, (New York, 1955) pp. 957-958.

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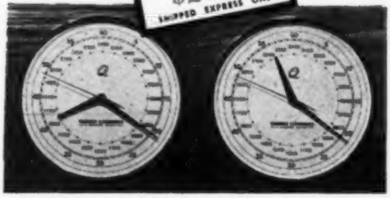

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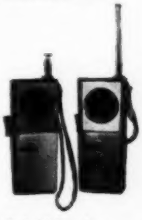

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Amplitude Modulation vs. the Carrier

Some easy-to-understand proof that a carrier is not affected by amplitude modulation.

The statement is often made in the study of amplitude modulation that the actual carrier *does not* change in amplitude during the modulation process. Many an old time AM ham will raise his eyebrows in horror; however the statement is true. We have all looked at the pattern of modulation on an oscilloscope using a linear sweep. If 100% prevails we note that the pattern varies from zero amplitude on 100% negative peaks to twice the amplitude of the carrier at 100% positive peaks. Hence the carrier amplitude varies. T'ain't so chum! You forgot what you were looking at and what the oscilloscope sees. The oscilloscope sees the complete rf signal. And the complete rf signal is made up of a carrier and two sidebands. The scope sees them all at once and gives you the composite picture. If you had a very selective circuit that would tune in the carrier and reject the sidebands you could look at the carrier all by itself. What you would see would be a nice smooth carrier that does not change in amplitude no matter where you set the modulation volume control.

At about this point in the discussion some joker in crowd says, "What will happen if you over-modulate and a 100% negative peak is maintained over a considerable period of time? Since there is no power during this period there can be no carrier. Surely this is too long a time for the flywheel of the tank circuit to maintain the carrier without damping out." Well believe it or not the original statement is still true. The carrier is still there and does not vary in amplitude during the process of modulation. This is a very difficult thing to explain physically. Let us try and see if we can explain this seemingly impossible situation.

First of all let us hasten to agree that the flywheel effect will damp out very rapidly if a circuit is loaded at all. **Fig. 1** is an oscilloscope pattern of the output of a frequency tripler which is loaded to some extent. There is a plate current pulse every third cycle. It is evident that even in three rf cycles the degree of damping is quite measurable. Secondly, the decision was made to set up the worst possible example of negative peak modulation possible, and observe the results. Therefore a demonstration type rf amplifier driven by a crystal oscillator was adjusted so that it would be di-

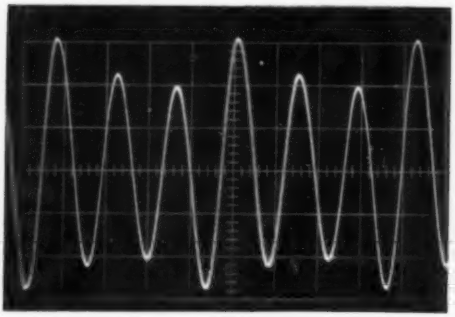


Fig. 1. Output of a frequency tripler.

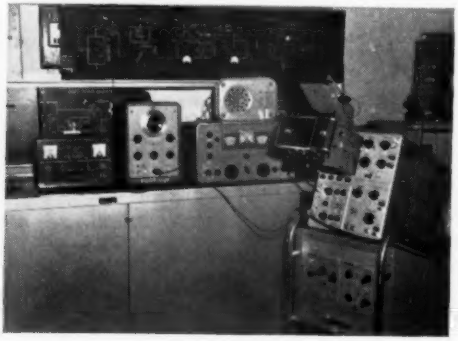


Fig. 2. Entire experimental set up.

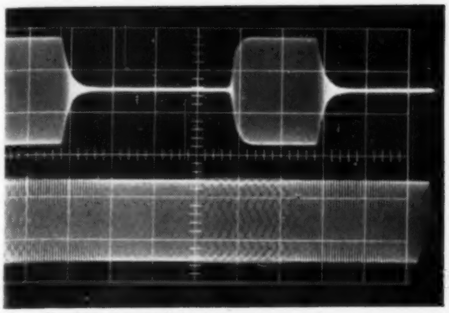


Fig. 3. Upper-modulation pattern from transmitter. Lower-carrier pattern (455 kHz) observed on HQ 160 receiver. Both viewed simultaneously. Moire on carrier caused by double pattern on scope.

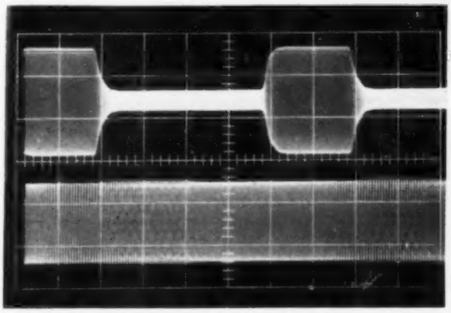


Fig. 4. Same as Fig. 3, but with less modulation. Note constant carrier amplitude in Figs. 3, 4 and 5.

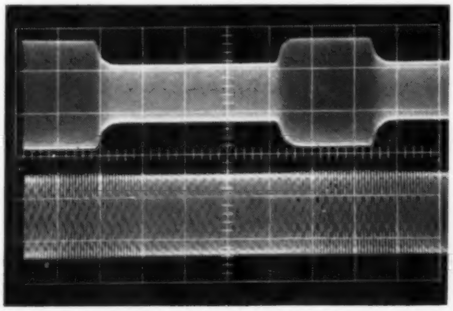
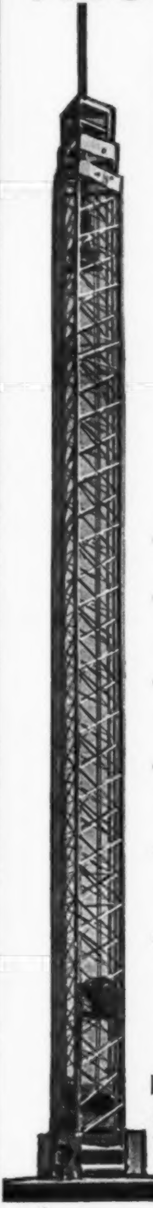


Fig. 5. Same as Figs. 3 and 4, but with less modulation.

rect modulated by a square wave generator. The signal was picked up by a Hammarland HQ 160 receiver sufficiently isolated from the crystal oscillator so that the carrier of the amplifier as observed at the 455 kHz *if* was much larger than that of the oscillator. The *if* of the HQ 160 was fed into a Tektronix 545 scope. Using 10 kHz square wave audio as a modulating signal, it is possible to observe the



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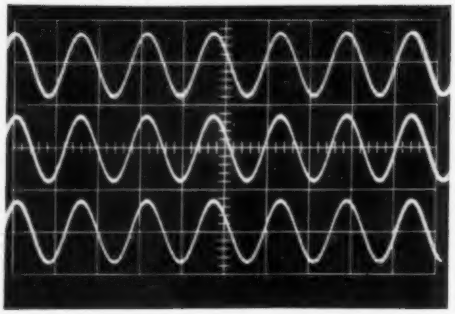

Fig. 6. Upper sideband, carrier and lower sideband. Taken in three exposures. Pattern moved and HQ 160 tuned for each exposure. See text.

carrier without either sideband or to observe either sideband without the presence of the carrier or the other sideband, when the receiver is adjusted to its sharp tuning position. The complete setup is pictured in **Fig. 2**.

Fig. 3 shows the modulation pattern coming out of the modulated amplifier, in the top portion, while the bottom pattern displays the carrier simultaneously (as viewed at the 455 kHz *if*) tuned in on the receiver. These two patterns were scoped simultaneously with the scope being triggered on the square wave. This results in a noticeable moire effect on the carrier display which disappears if the carrier is viewed without the second pattern being present on the scope. It should be pointed out that the period of nothing but center line in **Fig. 3** is on the order of 40 microseconds. Since the carrier frequency is about 4 MHz this would amount to time for 160 rf cycles, much longer than the flywheel could possibly maintain the oscillation of the tank circuit. *So the carrier is really there!* As can be seen from the figure the amplitude of the carrier does not change during modulation nor does it come in bursts. **Fig. 4** and **5** show the same conditions at less than 100% modulation. (Amplitude was adjusted at the scope to give the right size for making pictures). **Fig. 6** shows the upper sideband, the carrier and the lower sideband with the time base on the scope so that you can see the individual rf cycles. Note the nice wave shape and no evidence of damping. The picture was taken as a triple exposure rather than simultaneously. The upper sideband was tuned in first on the HQ 160 and positioned in the upper third of the scope, then snapped. The carrier was then tuned in and positioned in the center and snapped. Lastly the lower sideband was taken. So the pictures do not represent a simultaneous action and the relative phase is meaningless. They all look alike because a half dozen cycles of 3980 kHz practically match a half dozen cycles of 3990 or 4000 kHz. If you look at either sideband by itself and vary the modulation, of course the amplitude changes. With no modulation there will be no sideband at all and it will increase in amplitude as the gain is turned up. The carrier when viewed alone changes not at all regardless of where you set the gain control.

Non-mathematical explanation: It is true that during the negative peak we do have a total of zero power. But the factors that add up to zero are not zero themselves. The carrier is one of these factors. Also even those not mathematically inclined will agree that a square wave or any distorted wave can be broken down into a series of sine waves. Anybody who has ever operated a wave analyzer knows this. So why should a square wave yield anything different than multiple sine wave modulation? Don't forget the oscilloscope sees all of these frequencies at once when connected to the modulated stage and shows you the composite sum.

An interesting observation: A side observation of this experiment with square wave modulation with the carrier frequency of 3990 kHz was that it was possible to observe sidebands every 10 kHz for at least 400 kHz either side of 3990. This was a very impressive demonstration of why overmodulation causes "buck shot" the width of the band.

Once again, the amplitude of the carrier does not vary with amplitude modulation. The amplitude of the entire signal (composed of carrier and sidebands) does vary from zero to twice the amplitude of the carrier by itself with 100% modulation.

Hope this doesn't give you old time AM boys a nightmare!

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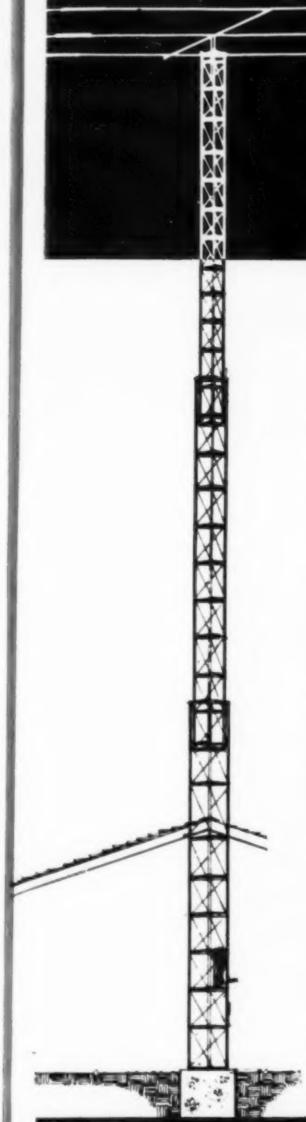

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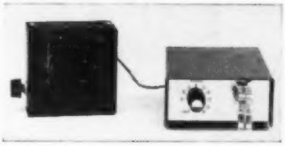
Super "Q" Products has just brought out a rotatable inverted V antenna for 15 or 20 meter operation. It is constructed from aluminum tubing with telescoping end sections so that it can be used on either 14 or 21 MHz. The manufacturer states that when the antenna is tuned up for operation on 14.275 with an SWR of 1:1, the SWR at 14.350 is not greater than 1.3:1. Since the input impedance of this antenna is 50 ohms, it can be fed directly with RG-8/U coaxial line and no matching devices are needed. The lightweight construction of this antenna features heavy polystyrene insulators which hold the tubing in the proper position and clamps that will fit any mast up to 1½ inches in diameter. The radiation pattern is bi-directional and attenuation off the sides of the antenna is approxiamtely 15 dB. The low center of gravity of this design and its light weight simplifies the problem of rotation since a small, light-duty TV rotator is more than adequate. Tests in windstorms have shown no signs af strain in winds up to 75 mph. The Roto-V is available express or truck freight collect for $29.95 from Super "Q" Products, Box 8405, 5704 South Staples, Corpus Christi, Texas 78413.

Lafayette HA-500 Ham Receiver

The new Lafayette HA-500 ham band receiver tunes the 80 through 6 meter amateur bands in six tuning ranges. It's a 10-tube double conversion superheterodyne. Among its features are tuned rf and first mixers, two mechanical filters, product detection, "always-on" oscillator filament, built-in 100 kHz calibrator, illuminated slide-rule dial, S-meter, automatically switched AGC for AM or SSB, and less than 1 μV sensitivity. Size: 15" W x 7½" H x 10" D. Price is $149.95. Write Lafayette for more information at 111 Jericho Turnpike, Syosset, L.I., N.Y. 11791.

Heath SB-610 Monitor Scope

The newest member of the Heath SB-Series is the Heathkit SB-610 Signal Monitor for both transmitted and received signals. It displays actual signal envelopes or trapezoid patterns from transmitters, and it will give an equally complete picture of signals being received. It can be used with low or high power transmitters from 160 to 6 meters and with receiver *if*'s as high as 6 MHz. Price is $69.95. You can get complete information on the SB-610 from Heath Company, Benton Harbor, Michigan 49022.



Trans-Key Electronic Keyer

The new Trans-Key transistorized electronic keyer offers either automatic (self-completing dots and dashes) or semi-automatic or "bug" operation (not-self-completing). This unit is completely battery powered and does not require connection to 110 volt lines. It has relay output so there are no worries about voltage polarity or method of keying your transmitter further, it is fully adjustable from a few words per minute to over 50 words per minute and features an adjustable dot-space ratio. Since it only requires 10 to 15 mils of current, the battery supply has a very long life. $29.50 from your local distributor or write to W6PHA, Global Import Company, Box 246, El Toro, California.

Motorola IC Projects

Integrated circuits (IC's) are finding rapid acceptance and varied application in industry today. The new book *Integrated Circuit Projects From Motorola* brings these useful devices into the grasp of hobbyists and experimenters. Because integrated circuits are the basic component of each project, the book begins with a brief explanation of IC theory and a definition of terms. The second chapter includes construction techniques and a pin location chart for those not familiar with solid state components. Six projects are fully described including, among others, an electronic organ, a binary computer, and a square wave generator. Each project begins with a brief circuit description, lists all the parts needed, and leads the builder through a step by step construction of the project. Schematics and drawings of the recommended layout are included as an aid to the builder. Testing and operation procedures complete each presentation. Available for $1 from your local Motorola HEP distributor. Motorola, Inc., Box 955, Phoenix, Ariz. 85001.

Motorola Solid State Projects

Eight projects for hams and experimenters are collected in the new book, *Solid State Projects From Motorola*. Hams might like to build such projects as a deluxe CPO, audio signal generator, regulated ten volt power supply, or six meter converter. Experimenters might enjoy duplicating the panic button, mini-fi transistor amplifier, intercom system, or motor speed control. All are clearly and completely described. Each project includes pictures of the finished product, layout diagrams and schematics, as well as a complete parts list. The projects are described in enough detail that even the beginner to electronics could complete them. To help those not familiar with the workings of semiconductors, a chapter at the beginning of the book provides basic theory. If one has not soldered semiconductors before, or isn't sure of the correct pin connections, he has no cause for alarm, as both are covered in the chapter on builder's hints. All use Motorola HEP transistors. The manual is available for just 50¢ from local HEP dealer. Motorola HEP Program, Box 955, Phoenix, Arizona 85001.

RCA Linear IC Handbook

RCA has just released a new book concerning IC design and applications entitled *RCA Linear Integrated Circuit Fundamentals*. This new manual, the first of its kind in the industry, is written primarily for equipment and system designers, but is of interest to anyone concerned with this new field in electronics. The first chapter is about general design considerations followed by basic configuration of the linear IC and of the operational-amplifier, and finally characteristics and applications of IC's. In the last chapter (applications) the basic family of IC's (differential amplifiers) is fully described. Dc, audio, video, *if*, rf, and operational amplifiers are covered. This last chapter includes more than half of the book, and appears to be the section most likely to be referred to by hams. Circuit diagrams, operating characteristics and performance data are liberally included throughout. Hams interested in keeping abreast of this rapidly expanding field would do well to invest $2 in this fact-packed book. Copies may be obtained from RCA distributors, or from Commercial Engineering, RCA Electronic Components and Devices, Harrison, N. J. 07029.

Motorola Microwave Designer's Data

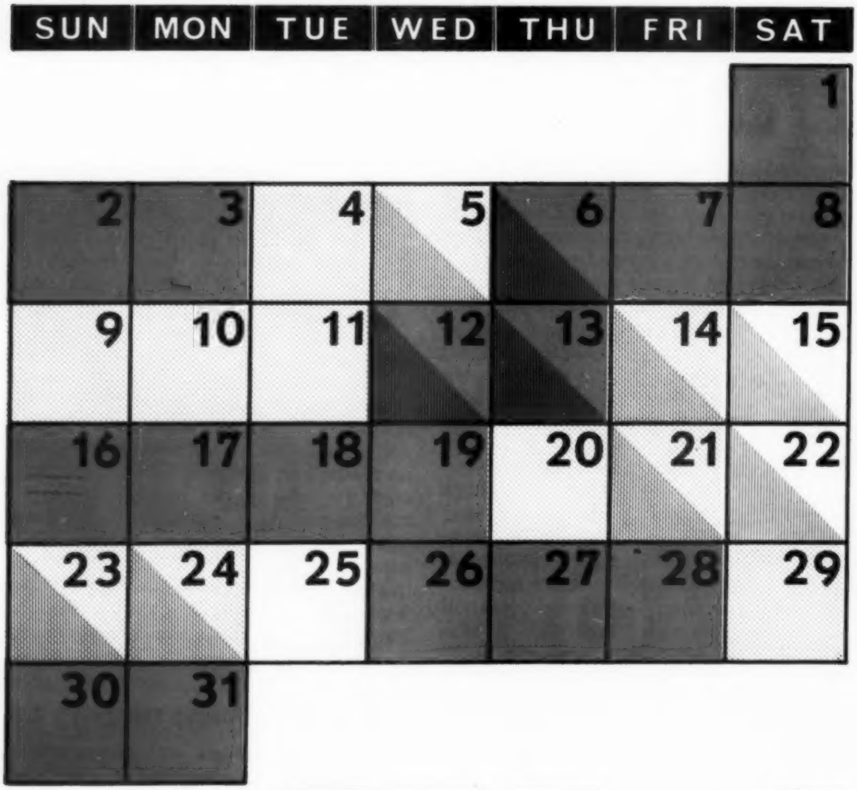
Designers who work with microwave should make sure that they get Motorola's Microwave Designer's Data Manual. It contains application notes and spec sheets on Motorola Epicaps, varactors, and rf switches. Write on your company letterhead to Motorola.

PROPAGATION

OCTOBER 1966

J. H. Nelson

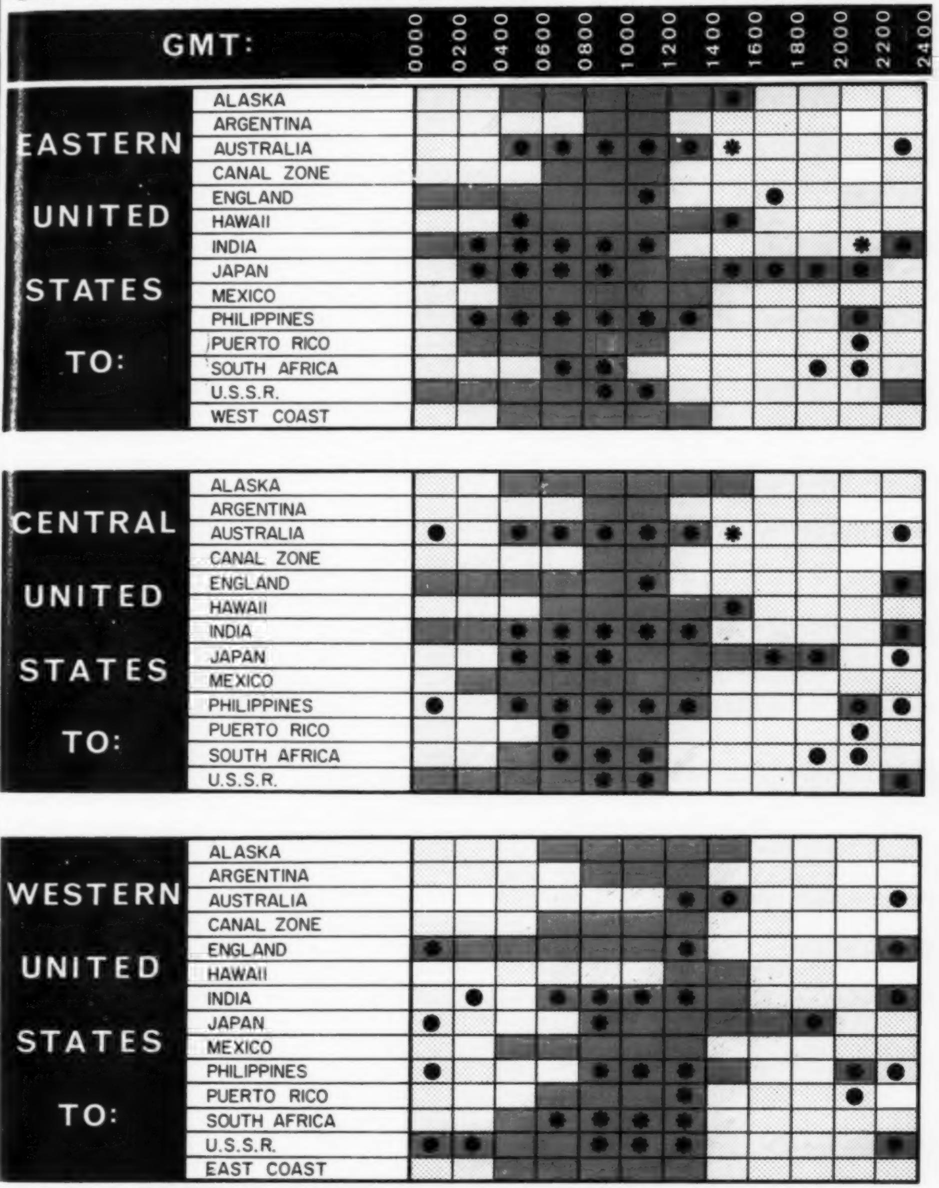
DX CALENDAR



SUN	MON	TUE	WED	THU	FRI	SAT
						1 ■
2 ■	3 ■	4 ▒	5 ▒ ◪	6 ■ ◪	7 ■	8 ■
9 ▒	10 ▒	11 ▒	12 ■ ◪	13 ■ ◪	14 ▒ ◪	15 □ ◪
16 ■	17 ■	18 ■	19 ■	20 ▒	21 ▒ ◪	22 □ ◪
23 ▒ ◪	24 ▒ ◪	25 □	26 ■	27 ■	28 ■	29 ▒
30 ■	31 ■					

legend: HF ■ good ▒ fair □ poor VHF ◪ likely

OPTIMUM FREQUENCIES HOURLY



Legend: ■ 7 ▨ 14 ░ 21 ☐ 28

Frequency in Megahertz

✱ Very difficult circuit this period

● Next higher frequency may be useful this period

Letters

Oscillator Error

Dear 73:

The schematic of the six volt oscillator on page 40 of the August issue is in error. On P2, the plug for 12 V, there should be no connection between pin two and the jumper connecting pins one and three. The plug as shown in the article would burn out the tube filament as soon as it was connected.

Don Marquardt K9SOA
Gary, Indiana

It Hertz

Dear 73:

I am not the type to go around complaining and protesting about everything on principle. But every now and then something gets me quite upset and makes me feel obliged to speak my piece.

When I read in the May issue that you were converting from cycles to hertz, my reaction was "He's joking; or at least, he won't start for about ten years." However, having now looked through the June issue, I see that you mean business. And I would, therefore, like to register my objection. If you want to turn 73 into a crusade for international cooperation and unity, why stop with Hz? You should certainly use European schematic symbols and tube designations, and while you're at it you could publish the whole magazine in Esperanto.

Forgive the over-dramatization, but what I'm getting at is this. Official government policy notwithstanding, a switch from cps to Hz in a magazine like 73 should **reflect** such a switch on the part of its readers; it should not be done to try to extort such a switch from them.

I am 18 years old, and for the foreseeable future, I for one shall stick with good old cps, in writing and speaking, unless and until I be convinced that a change to Hz for internal American usage has been about 95% accepted; at which time I would yield to the majority. I do not, however, believe that such a point has been reached, nor do I believe it to be the proper role of your magazine to push it.

When I see Hz, kHz and MHz in place of cps, kc and Mc, particularly in a strictly domestic publication, let me tell you, it hertz.

Alan Gott K3UOU
Silver Spring, Md.

Compliments

Dear 73:

Congratulations on your informative and interesting magazine. As an electrical engineer and builder of my own equipment, I am particularly enthusiastic about your construction articles. They incorporate "state of the art" methods in projects worthwhile to the amateur.

I would like to see more reference type articles such as the one on coaxial transmission lines in the July issue. Good work!

Dean Farrish WB4DAS/DL5LW
HDQ, Seventh Army Signal Section

Dear 73:

July '66 issue—the most diabolical cover(s) yet!! I pick the damn thing up upside down everytime!!!

And I won't even mention Batham—even upside down: sick, sick!

Swell solid state articles, though. You're on the beam with the latest scoop in that department.

John Anslow WA6DPJ
San Francisco, California

The design used in the cover is by WA4VAF and WA4-WOL. Somehow that got left out of the July issue. Paul.

Dear 73:

My compliments to you for that April issue. Since we all read **Playboy** (who doesn't) even the non-hams get a laugh out of it. Keep up the excellent work. Even though we can't operate from here, your magazine is well read and discussed by quite a number of hams, non-hams, technicians, tech reps, etc., at this location.

Arv Evans K7HKL
Viet Nam

Dear 73:

Just a quick note to congratulate you on the evolutionary path your magazine is taking. The vast number of articles per issue and the up-to-date subjects have, in my opinion, considerable appeal. Of great importance is the **mix** between construction articles and information articles (origin of the code, explanation of RTTY). 73 started out with an image of "How to do it," but appears to be broadening lately. Good! For pete's sake fellows, don't let it go too far in any one direction.

The April issue was particularly clever. The Playboy theme is timely and was well satirized by K3SUK's illustrations.

Keep up the good work.

A. Schechner
Philadelphia, Pa.

Micro-Ultimatic

Dear 73:

Since publication of the "Micro-Ultimatic" article in your June issue, I have received quite a bit of correspondence and am pleased at the number of CW hams who have built the keyer. There are several questions many letters have in common. Also there are a few suggestions which I feel would aid in the construction and debugging of the keyer. Therefore I am writing to help those others who may not yet have written me.

First, I must apologize for implying an identity in performance between the Micro-Ultimatic and Kaye's original Ultimatic back in 1955. There is a fundamental difference in performance between the two keyers, and that is this: With both key paddles closed at the same time, the Micro-Ultimatic will generate a string of alternate dots and dashes. This is normal. The 1955 Ultimatic does not respond the same way. I thank K6LTS for the question which brought this difference to light.

An improvement in performance is had by raising the output capacitor in the power supply to about 1000 µF. With the 200 µF in the original schematic, 120-Hz ripple was excessive and caused the pulse generator to tend to lock to subharmonics of the ripple. This had the effect of making the keyer "prefer" certain operating speeds.

There seem to be no errors in the article as published. Several hams have written me to describe their success in building and operating the keyer. This is somewhat unusual, since most letters would be from builders who are having trouble.

It is quite important that no rf energy get into the keyer. The usual shielding and filtering practices are called for. Make sure that the keying output to the transmitter is not a path for rf energy. A low-pass filter cutting off around 100 Hz and mounted *at the transmitter* was required in one stubborn case.

A few cases of defective integrated circuits were reported. Fairchild makes a practice of replacing these dead-on-arrival units through their distributors at no charge, according to a friend of mine. So the builder needn't despair if his $4.00 flip-flop doesn't work. The IC's can be ruined however, by inadvertent application of B+ to any output lead if the transistor is conducting at the time. So precautions common to any semiconductors are required.

I have just been advised by Fairchild that the prices on the epoxy micrologic used in the keyer have been greatly reduced, as follows: The 9923 flip-flop is now $1.50; the 9914 gate, $0.80 in 1-24 lots. This cuts the price of the IC's in the keyer by nearly two-thirds. This should be welcome news to those considering building the keyer.

And finally, I would be pleased to contact anyone using the Micro-Ultimatic on the air. 7060 kHz at 0100 GMT Wednesdays I'm usually on.

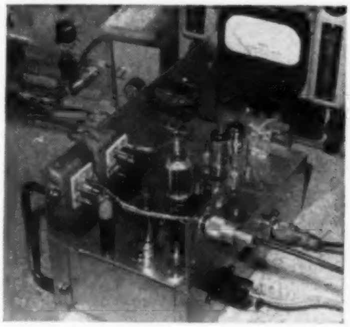
Tom Pickering, W1CFW
Portsmouth, R. I.

Dear 73:

The article by W1CFW in the June 73 on the Micro-Ultimatic Keyer is worse than any QST article ever published and as to reader interest, perhaps only one ham in the entire subscription list would be interested. Your articles are too uninterestingly technical. One can buy a good keyer cheaper than this complicated jobbie.

James Russell W8BU
Fairview Park, Ohio

Six Meter Transmitting Converter



Dear 73:

Thought I'd send along a photo of my 6 meter SSB transmitting converter which I constructed from your November issue. Designed by Joe Owings K0AHD. I found the rig worked excellently and no problems were encountered in construction or operating. Since March I have been assigned overseas and hold the call SV0WV and operate 20 meters mostly.

Keep the fine articles coming!

Dick Searle, K1VWJ/SV0WV

Government Support of Hams

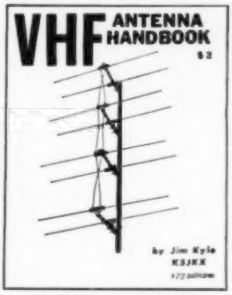
Mr. Stewart H. MacKenzie
Huntington Bch., California
Dear Sir:

This refers to your letter dated June 12, 1966, which requested information concerning the next international telecommunication conference, its substance and potential impact on the frequency bands allocated to the Amateur Radio Service.

There has been a considerable amount of publicity during the past few years concerning the next international telecommunication conference and the possibility that amateur frequencies may be reallocated to other services. This publicity has been generated by and given extensive coverage in the national amateur radio magazines and periodicals and is an indirect result of the 1959 Geneva Telecommunication Conference which provided some frequencies in the 7 Mc/s amateur band for broadcasting in the African-European areas.

The amateur frequencies established for the American continents at the international conference held in Washington in 1927 have had only very minor modifications since that time. The United States proposals to the international radio conferences have always sought to maintain the allocation of the amateur bands, and it is expected that future proposals will endeavor to continue this status. However, with the creation of new countries, there is a continuing demand for more frequency space for the requirements of these new nations. The amateur frequencies are fertile ground in which to exploit their demands and it is highly improbable that such countries would be sympathetic to the amateur cause until their needs are met. It is this factor, among others, that has brought forth widespread fear in the radio amateur circles that the next international conference might reallocate segments of the amateur bands to other services. It is important to note, however, that a conference authorized to treat a subject such as this has not been scheduled and probably will not be for at least the next three or four years. If and when such a conference is called there is little likelihood that the United States will depart from its pro-amateur position. In any event, the public will be afforded an opportunity to comment on the position developed by the United States for that conference.

Ben F. Waple
Secretary
Federal Communications Commission
Washington, D.C. 20554



The VHF Antenna Handbook

The VHF Antenna Handbook is your complete guide to VHF and UHF antennas. This outstanding book is by Jim Kyle K5JKX, one of the outstanding technical authors in the electronics field. The VHF Antenna Handbook covers complete theory and all practical details for every type of VHF and UHF antennas. A special feature is the commercial antenna catalog section. If you're interested in VHF, you should have this book.

Price is $2 from

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Halo antenna
Abe Lincoln
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Mattress array
Sterba curtain
ZL special
Long and short yagis
Weeping willow
Quad antenna
Helix
Cross beam
Circular quad
Transmission line antenna
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V antenna
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And much more

73 Magazine, Peterborough, N.H. 03458

IMPORTANT NOTICE

We've had to revise our subscription list to satisfy the new Post Office regulations. Now all of our stencils are filed by Zip Codes. We can't find your address without your Zip Code, so please include it with all correspondence.

RSGB Handbooks

Dear 73:

About two weeks ago I received the RSGB Data Reference Book, and a day or two ago received the Amateur Radio Handbook. I still have to receive the RSGB Amateur Radio Circuits Book, which I assume is still out of stock? [yes] I am pleased with the British books and hope the other one is forthcoming soon. My best wishes for continued success of "73". You give the hams the meaty articles they want and not a lot of contest, etc.

H. F. Happoldt, K3YPV
Haverford, Pa.

Dear 73:

I have subscribed to the 73 magazine for the past couple of years and articles have appeared from time to time regarding the FCC, though to my knowledge there has been no mention of consideration to the old tried and true AM amateur stations still trying to enjoy the privilege of operating only to be washed by the unnecessary splatter of sideband operation killing the use of ten to fifteen kc of the band which could be used by perhaps four or five AM stations [not at once. Ed.].

What I am asking of you is if a poll of some kind could be gotten in favor of consideration to AM and submitted to FCC so there could be a bit of protection for the old and reliable type of transmission.

I would be very happy to help on any reasonable suggestion to help and preserve the use of AM to better advantage.

Thank you very kindly.

Claude Keneaster WA5LFL
El Paso, Texas

Build the modern, easy way with circuit boards and solid state!

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W1JJL's code practice oscillator-monitor described in the July '65 73 belongs in every shack and shack-to-be. It's inexpensive and works well. The drilled board with all components locations marked is only $1. The board with the parts mounted on it is $3. Or you can buy it mounted in an attractive case as shown above, complete with battery, for $7.95.

METER
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FSM
ANT.

Here's an excellent field strength meter. It's easy to use with a built-in amplifier for use with any 1 mA meter. See the article in the December '65 73. The drilled screened board is $1. With the components mounted it's $3. Complete in an attractive case, the price is only $5.95.

A good HF-VHF SWR bridge doesn't have to cost a lot. You can make one from an inexpensive meter and our special pick-up line described by W1JJL in the September '65 73. The line with holes drilled is only $1, or you can get it with parts already mounted for $3.50.

Want a good keyer? We've got boards for two: WA6TSA's Uni-Junction Keyer in the January '66 73 can be built on our fiber glass board with the holes drilled and parts locations shown for $4.95. With the transistors mounted on it, it's $8.95.

Another good keyer is WB6AIG's Kindly Keyer in the July '66 73. The fiber glass board for this keyer, with all those 120 tiny holes drilled is only $4.95.
K3LCV's FET Voltmeter is very useful. It's described in the July '66 73 and a fiber glass board for it is $3.50. See the Siliconix ad in September for the FET's at a fantastic price.

COMING SOON: WATCH 73 FOR THESE PROJECTS!

Novice receiver and transmitter. VHF and UHF dip-meters. One watt six meter transceiver. Capacitor-resistor checker. Portable FM monitor. Wavemeters. Calibrators.

Prices include postage in U.S.A. Connecticut residents include sales tax. All boards in stock for immediate delivery.

Harris Company

56 E. Main Street Torrington, Conn. 06790

Gravitation Error

Dear 73:

Dwayne Hendricks WA8DZP, of Tek-Dayme Research, has sent me a letter about a typographical error in a letter to you published in the May issue of 73 about gravitation. The volume of the gravitation was given as 6.3×10^{-12} cm^3. It should be 6.3×10^{-42} cm^3. These values were obtained from Nuclear Dynamics by Dr. Nicholas J Medvedeff, one of the leading physicists in the U.S.A

Tom Appleby W3AX
President
Mahlon Loomis Scientific Foundation

The FET Voltmeter Is Great

Dear 73:

I am really surprised at the way 73 magazine has passed up the other two major ham magazines. I buy a ham magazine because I want to learn more about solid state circuits and 73 has more information about this than any other magazine. I have built the Field Effect Voltmeter (July, 1966 page 34) and Richard Palace, K3LCU, is right. I have put aside my high-class test equipment for this low-cost unit that makes others look sick. As you know, it doesn't run from 110 Vac so you can take it with you in the field. Keep up the fine work and articles on solid state circuits. Thanx for a good magazine.

Tom Adams, WA6KSS
Monrovia, Calif.

Ham Use of Semiconductors

Dear Paul:

I read with great interest (and fulminating concern) your comments in the July issue regarding the apparent inability of the "Handbook" to keep up with the current state of the art so far as semi-conductor technology is concerned. I have felt for quite a few years now that electronics is outrunning the "bible", but you are the first I have run across to state it in print. My congratulations.

The broadcast industry is one of the most conservative concerning adoption of new electronic techniques. After everybody else makes all the mistakes, broadcasting will step in and utilize equipment that has had all the bugs ironed out. Yet almost all new broadcast equipment bought or built today is 100% solid state. Transmitters are available for no more than 20% greater cost over tube models up to 5000 watts that are all transistor except for the final. The two primary reasons for retaining tubes in finals are cost and susceptability to lightning damage.

For a business that bases its entire operation on the successful, economical operation of reliable electronic equipment with a minimum of man-hours (these men have other things to do) spent on upkeep, indifference to the advance of the state of the art would be technical suicide.

I would feel the same thing might apply to ham radio. Have not we been famous as technical innovators? Hasn't it been our reputation as the hobbyists who "play" with electronic inventions to be the first to come forward with the practical systems? Maybe I'm an alarmist, but I feel that hams have been in the forefront of electronic engineering until just recently, but now we seem to be falling behind. I don't know a radio amateur worthy of being called one who can't tell you what happens inside a vacuum tube, but I know very few who can say what happens inside a transistor coherently. All that comes out is some foggy reference to the movement of "holes" or some bland statement that "they work just like tubes, except you reverse the B plus and lower the voltage." Concepts like these are what perpetuate the general feeling among hams that transistors are unreliable, but interesting little novelties. Nothing is farther from the truth. Used correctly they are the most reliable and interesting active electronic component available to us today. It is about time the hobby as a whole accepted this and got on the bandwagon. This means the Handbook needs to be bigger . . . lots bigger. Maybe this will cost more, but it would be worth it. Send the editors back to school if necessary. It seems a sad criticism that there were more technically valuable semi-conductor articles in the July issue of 73 than in the entire 1965 Handbook. 'Nuff said?

Steve Broomell WØPGN/7, Chief Engineer
KAII, Casper, Wyoming

Get Your Extra Class License

Dear 73:

My article on the extra class exam and programmed texts appeared in the July 1966 issue of 73. I have had tremendous response to this article, and I have received at least a letter per day since that issue came out. Boy, 73 articles really get the coverage!

Here's some additional information I've been giving to those hams who responded to my article. First of all, the sample programmed lessons of Fig. 2 in the article didn't come from any published text. I wrote these myself especially for the article. Maybe I should write a programmed book.

Second, since I wrote the article there have been several more programmed texts published. I've listed these below. There is a pretty wide selection available now and most hams shouldn't have too much trouble in finding one to suit them. Also, new programmed texts are coming out every month or so, so keep in touch with your local bookstore.

Recent Programmed Texts

"A Programmed Course in Basic Electronics", New York Institute of Technology Series, McGraw-Hill Book Company publisher.

"Electronic Troubleshooting", Philco Technical Institute, Prentice-Hall Inc., Publisher.

"Logical Electronic Troubleshooting", by Donald Schuster, McGraw-Hill Book Company, Publisher.

"Electron Tubes at Work", by J. B. Owens and Paul Sanborn, Tutor-Text, Doubleday.

"Fundamentals of Transistors (Programmed), RCA Service Company, Prentice-Hall Inc., Publisher.

"DC Circuit Principles",

"Simplified Transistor Theory", both by Training Systems Inc., and Stanley Levine, Hayden Book Company Inc., Publisher.

I am pleased that my article has been so helpful, and thanks to 73, it was published.

Louis E. Frenzel, Jr., W5TOM
Houston, Texas

AM on 20? Bah.

Dear 73:

There are a couple of items having to do with frequency allocation and usage in the 20-meter band which have been bothering me for quite some time. Although both subjects have been brought up in the past, I think the time is right for further discussion in a national magazine.

First, I feel that the frequencies between 14.150 and 14.200 MHz are a "vast wastland," i.e., they are receiving much less use than the rest of 20 meters. From my vantage point on the West Coast, it appears that the only use of this band segment is: 1. Some AM (and a few SSB) stations from VE-land; 2. An occasional DX station transmitting around 14.190 to 14.199; and 3. An occasional phone patch from KR6, etc. I maintain that all three of these uses are absolutely nonessential and this band segment would be put to much better use in this country if it were open to U.S. phone stations. If the FCC goes ahead with incentive licensing, perhaps part or all of this segment could be used by amateur extra licensees only; otherwise, why not open it to all holders of conditional class or higher?

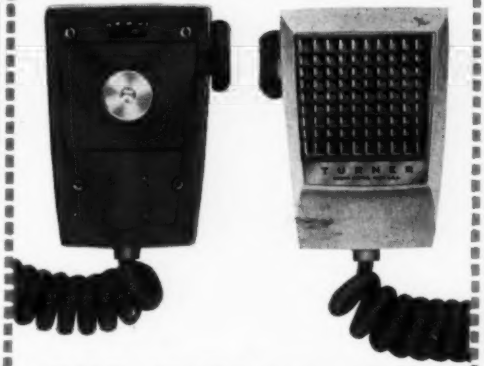
The second subject concerns what I've been hearing lately between 14.200 and 14.250 MHz—that portion of the band set aside by "gentlemen's agreement" as the sole province of AM phone stations. Recently this band segment has been more and more populated with SSB stations; furthermore, many DX stations have been working U.S. SSB stations here. This is a logical development in view of the number of amateurs with transceivers who cannot send and receive on different frequencies.

I propose a new gentlemen's agreement: An agreement by AM stations to refrain from transmitting on 20 meters. This shouldn't be much of an inconvenience for anyone, since there seems to be less AM activity on this band as time goes by. Those who choose to work AM as a matter of personal preference can do so on other bands (with less interference from "side-winders"). Certainly there remains no argument on the relative merits of SSB versus AM for long haul work. Need I say more?

I hope that my ideas will be of interest to other active amateurs; I am sure that their implementation would be of great value to our important 20-meter phone band.

Gerry WA5FRL/WB6PHU
Pacific Grove, Cal.

EVERY HAM
SHOULD HAVE ONE



THE TURNER M+2

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An excellent item for owners of Turner's +2 base station model, the M+2 has the same tailored frequency response of 300-3,500 c.p.s. as the +2 for the clearest voice transmissions.

Buy the new M+2 for your mobile transceiver and get the best and most powerful transmissions ever. Battery, dash bracket, 5 foot coiled cord, and instructions included. Wired for relay switching.

Net price $23.70

Model J-M+2 (for sets with electronic switching).
Net price $23.70.

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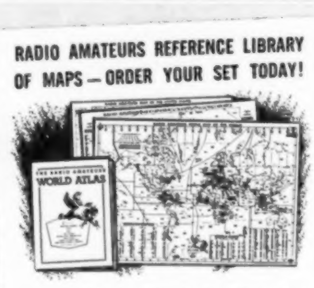

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An OT Looks at Code

Dear 73:

For 35 years I have felt that it was right and proper that every amateur should learn the code for a license. I went through it, why not everyone else? Recently I have changed my mind!

I have been helping a couple of Novices improve their code. One is 79 years old, the other a brilliant young engineer. Both of these fellows are in the last months of their Novice licenses, and, although they are on the verge of passing the code, neither can quite make the grade. The old gent will never be able to write 13 wpm with a pencil. His old fingers just won't go that fast. His Novice license is a means of something to do. He lives out in the desert by himself, and will now have to give up. The young engineer understands all there is to know about electronics and designs our defense systems. At home he copys 20 wpm but blows up at the radio inspectors office. Every month for five months he has plunked down $4.00 to take the test and missed by one letter. He never expects to use CW, in fact he hates it, but likes SSB and construction. The old gent is hard of hearing, CW comes through where SSB does not. There must be a moral.

Have we been wrong? Why can't the Novice stay on forever if he likes CW at 5 wpm? Who is he harming? How many Novices can pass 13 wpm at the end of the year? I have not found one with whom I have been in contact? How many phone men could pass the code if the RI came around?

The excuse for CW was to provide CW operators for the military. Do we still need CW operators when the infantry soldier has digital communication back packs?

Since our license method is so screwed up, why not leave the Novice alone for a few years until he CAN copy better and give him a decent chance.

What was wrong with the old test 30 years ago: 10 wpm (a reasonable speed) and some theory? Whose ego are we trying to please by the complexity? A few who want special privileges because the bands are so crowded. At one moment we holler for more amateurs and the next for Extra class licenses. With the few Extra class licenses issued, I doubt if they will make any impact on increasing our engineering ability to save the electronic industry. Engineers are made in colleges. We are hams. Why not leave us alone?

I say let's have one reasonable license and a continuous Novice if we must, but let's *do something* and get this mess straightened out. It's been hanging fire too many years.

Ed Marriner, W6BLZ
La Jolla, California

P.S. I have the Extra class amateur besides commercial first telegraph and phone licenses.

Green, No. Articles, Yes.

Dear Sirs:

I do not in the least agree with your Mr. Green; in fact I think he is a rabble rouser.

However I must admit that 73 is printing some very good articles. So please enter my subscription for one year and I'll enjoy the magazine and try to ignore Mr. Green.

Eugene Bulton W6FVE
Modesto, California

On Wayne Green

Dear 73:

So you wonder what sort of a guy he is? Is he a crabby basket, an angry old man or an impatient young man with ulcers or what?

I confess I waited at the Air Port in Nairobi with mixed feelings. I had had several Q.S.O.'s with him and found him quite pleasant but his editorials!!

He must, as a successful author and editor of many years, surely be at least fifty or sixty. I had a hearty respect for his views and his editorials but some of them were Vitriolic and his debunking was at times merciless.

He would of course wear a tired lined old face showing the strain, on the other hand he was looking forward to skin diving in our lagoons, it didn't quite match up.

First Larry and Jim arrived and then a pleasant looking young man of about forty came through the barrier with a wide grin across his face. "Hello Robby, nice to meet you" I was holding up a C.Q. and a Q.S.T. magazine for him to identify me in the crowd. He took the joke very well and we had a good laugh. My qualms vaished—for good. He is most entertaining to talk to and is interested in everything on this little earth and beyond including an inquisitive mind on flying saucers! A vast fund of general knowledge, an open mind (most surprising of all) and has a youthful burning enthusiasm for some of his hobbies of the moment combined with the maturity of well balanced views and opinions.

You have to be wide awake when he embarks on red hot topics such as the possibilities of us losing more ham bands. He feels far too many of us don't realize how easily we could be voted off all the bands by fragmented Africa, each separate little country with a voting power the same as U.S.A. and U.K. In fact I'm quite worried about it now but its a comfort to hope that the Crusaders like Wayne will save some of it, somehow, I hope!

About his editorials, I feel he has an impish sense of humour behind it all and perhaps a curiosity to see what would happen or how people would react! So when he writes his outbursts he keeps his tongue in his cheek. That's my opinion only of course but one day of safari is like a month on a ship or years of acquaintance.

I had a shock coming when I turned him loose in the shack. His left hand got cold, in fact it froze solid, on the microphone and he couldn't let go until 2:30 a.m.

He made his stateside contact and got his home messages off and said "Mind if I give a few boys a 5Z4?" He then started working three a minute with occasional short QSO's with special pals. It might surprise you but Wayne is an accomplished operator he was finishing off my log book when I went to bed and next moring I found a neat pile of foolscap paper closelined with 48 contacts per page!!

I didn't count up the contacts but they were quite a few hundred and for stretches ran three to the minute. He controls the crowd well and is a cool operator. I asked him why he ticked off one lid and left another alone, in fact went out of his way for him. It turned out that by the call sign the guy was pretty new whereas the other one was an old prefix "who should know by now how to operate."

He had that impish grin on again and was obviously wondering how the guy would react. The guy reacted ok and Wayne soothed him with a kind word and settled down again to three a minute.

Ok, so what, I know a few other guys who can do that but they are not Editors! Wayne does all his hobbies well and goes flat out.

When on safari we drove up to a fine herd of Elephant and Wayne was filming away. Suddenly a second herd appeared behind us. We couldn't go backwards or forward as we were on a swamp path. The second herd wanted to join the first herd and we were in the way and awfully close to them. Wayne just said "the first group is the better" and went on filming them. He's cool, outwardly anyway!

I usually get fun telling visitors "try again with the lens cap off" and so on, but Wayne used his movie and three cameras and a Polaroid in quick succession without any fluffing. He keeps them as preset as possible, that is, ready to shoot which is a great help to me as I found I could take him right up to a beast—and in an incredibly short space of time he had the shots he wanted and said "ok" and we slipped off before the animal could decide what to do about it.

The Masai guide spoke in English but occasionally spoke in Swahili for my benefit and said "Bwana Hapana Mbia" which literally means "The man isn't bad" which is high praise from a Masai warrior. It means of course that Wayne performed well. If he hadn't the Masai would have sniffed, spat out of the window and clammed up!

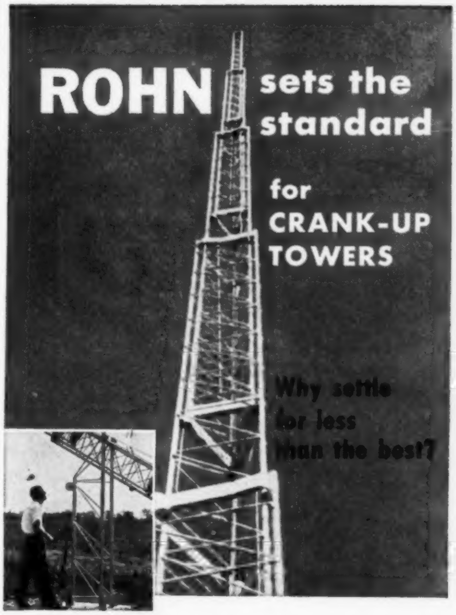
I hope Wayne will tell you of his great travel saga—it will be interesting if he does I promise you.

So there it is, a delightful companion, an alarmingly high I.Q., very thoughtful, hardly drinks, good fun and game for anything.

I must get this letter off to "73" magazine and see if they'll print it quick before Wayne gets back!

By the way—he eats too much!

Robby Robson 5Z4ERR
Nairobi, Kenya
August 11, 1966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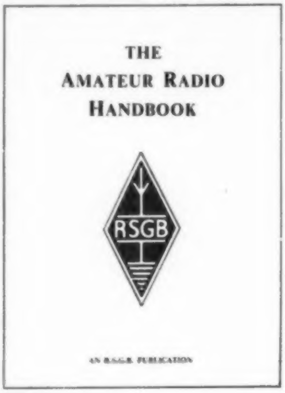

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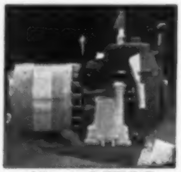

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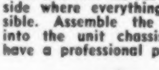

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We started quizzing the Alitalia people carefully to find out why our flight had been cancelled and when. The story we got was that it had been cancelled at least a day eariler . . . well before we had even left Boston. Why was it cancelled? Well, they explained that due to the U.S. airline strike there was a lot of money to be made in transatlantic flights and that the plane had been put on that run since it would bring more profit. I don't know how IATA feels about this sort of thing, but I'll bet the FAA would raise hell with an American line that pulled this.

That night we had dinner in Athens, hotel and food courtesy Alitalia. This was nice, but we were losing over $100 a day on our safari. The next morning we did the Acropolis and snapped beaucoup pictures. We did OK in Athens, only losing three cartons of cigarettes to the taxi driver that took us to the Hotel room (Hotel Elektra). It could have been much worse.

The flight to Nairobi left about 1 am the next morning (Friday) and stopped for an hour at Cairo at 3 am. Postcards were 25¢ each so we looked but did not buy. Next Asmara in Ethiopia for another stop. Then on to Addis Ababa where we stopped for an hour and a half while Africans crawled all over the plane cleaning it. It was an Ethiopian Airline plane, so this was reasonable. Every flight was jammed solid and there was no possibility of sleeping in the crowded tourist section. We were rubbing elbows with men in white sheets, colorfully robed Africans and a good many Indians.

We set down in Nairobi at noon and, the customs formalities done, found Robby waiting for us. He identified himself by holding up a copy of QST and CQ. Bless him. Shamsu Din, the fellow who booked our safari, was also waiting for us. We drove about four miles into town and had a short lunch under the big thorn tree in front of the New Stanley Hotel. At the next table, I saw with dismay, was a long haired boy in tight dungarees and a black leather jacket. Good grief! He was with a group of boys and girls that could have been transplanted from Peterborough, New York or Stockholm.

The afternoon was taken with getting our hunting licenses, selecting our guns and registering them. Groggy almost to the point of incoherency we sacked out at Robby's house for the night. The next morning (Saturday) we admired his formidable barrage of antennas and nice station. I wish we'd had time to get on the air for a little bit, but we had to get downtown for a little shopping before driving to Nanyuki some 125 miles north for our safari. We bought safari shoes, safari jackets and safari hats and walked with just a touch of swagger down the main street of Nairobi. After stocking up on film we piled into Shamsu's car and were on our way. The car had a king pin about to give away plus two front wheel bearings burnt out so we didn't make very good time. We skipped lunch and drove straight through, stopping only for a half hour in Thika to have one of the wheel bearings replaced. We arrived in Nanyuki at about four in the afternoon.

Nanyuki is a very small town right next to the highest mountain in Kenya, Mount Kenya (17,000 feet). Nanyuki is right exactly on the equator, but because it is about 6000 feet elevation on a very large plain, it is relatively cool. There is a main street about two blocks long with a dozen or so stores run by Indians (called Asians) and off a block away one row of stores run by Africans. One that sticks in mind was the Butchery and Tea Room, an interesting combination. Shamsu suggested that we shop in the Indian shops as we might get into trouble in the other part of town. Hmmm.

The Sportsman's Arms Hotel turned out to be a pleasant place . . . rather run down by American standards. Old battered furniture, everything in need of paint, etc. The hotel is

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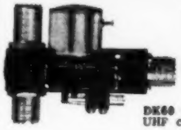

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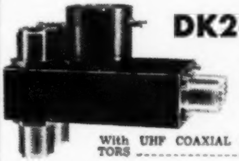

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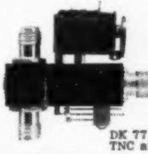

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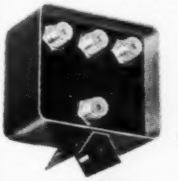

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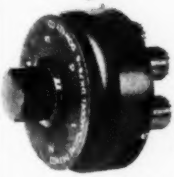

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Wayne on termite hill.

made up of 30 or so rooms in a motel arrangement . . . some all in a line, some separate cabins. My room had two single sized beds, a clothes closet and an old dresser. There were two beat up chairs. The bathroom had an old tub and a washstand. In a small separate cubical was the toilet. The lighting was from a hanging overhead bulb. Meals turned out to be large with six to seven courses, though the preparation was not inspired.

Relatively few of the Africans speak much English and you start right out getting a basic vocabulary of Swahili. You can get along pretty well with as little as fifty words and with 500 you are fluent.

Soon after we had had some sandwiches to make up for our missed lunch Fred Seed, our White Hunter, arrived. We set out immediately to zero our rifles and get used to them. We drove about two miles out of town to a rifle range and proceeded to see what we could do with a 100 yard target. One rifle turned out to be defective and it was nearly impossible to extract the used shell. The other worked OK, but was way out of adjustment and it took about 14 rounds to get it on target. Those shells cost over 50¢ each so we fired sparingly. Oh well, only one of us can shoot at one time anyway . . . and only Larry and I will be doing the hunting. Jim decided to devote his time to filming.

On Sunday morning we all drove out to the range again to make sure we had the .338 on target . . . seemed OK. Then we were off on the hunt. I was up first so I sat by the door of the Land Rover with Larry in the middle and Fred driving on the right hand side. In the back seat were our two gun bearers, watching out the sides for game, and Jim in the middle, popping up through the hatch in the roof to take pictures. In the very back of the car was the skinner, just in case we managed not to miss something.

The countryside was grassy . . . sort of a crab-grass stuff . . . with acacia (aa-case-eeya) thorn trees everywhere). These spindly trees grow about ten feet apart, are covered with extremely sharp thorns and are swarming with ants. The ants bite into the bark, causing it to swell up into blisters an inch or so in diameter, where the ants live. These are called whistling thorns because the wind blowing by these millions of blisters makes them whistle and you hear this eerie whistling sound when the wind blows.

We drove a couple more miles and were definitely in the bush. We began to see signs of animal life with little herds of Thomson's Gazelles running around. Fred pulled to a stop and pointed out a large Tommy ram and said to go after it. Kerede, my bearer, handed me the gun and I tried to load it. The shell refused to go into the chamber. I poked the shells in the magazine to get them to pop up and threw the bolt again only to have two shells try to jam in. I took them out and feverishly put them back in the magazine and tried to load again. No good. After about a minute of this ridiculousness I finally got a shell in the gun and the gun on safe. By then the Tommys were off in the woods out of sight. Kerede took the gun and we started off. I walked as carefully as I could, trying not to make any noise. Kerede crouched along, with me bent over trying to keep up with him, breathing harder and harder at the unusual position and suffering a bit from the thin air at this altitude. It was hot and sunny, about 75°.

We tracked them for about ten minutes and then Kerede motioned that they were spooked and we returned to the car. We drove for another mile and spotted another group of Tommys and we were off again. Same result.

Then, as we came out onto an open field I saw a lone Tommy ram grazing. I looked through my binoculars and he looked like a good trophy. Nearby I spotted a small grey dog sneaking up on the Tommy . . . it was a jackal. I jumped out of the car, took the gun and got in the clear and aimed as carefully as I could. A Tommy is about three feet high and not a large target. This one was a tiny tan spot in my scope wavering back and forth across the cross-hairs. I squeezed the trigger and watched for the puff of dirt and running Tommy. Instead the Tommy did a little flip and dropped. I was astounded. I reloaded in case he jumped up again wounded and ran across the field to him. He was about 200 yards away and I was well winded when I arrived. The shot had caught him in the back and killed him almost instantly. Not bad for that distance.

It seems a shame to kill these beautiful little antelopes, but they are a pest to the farmers and cattlemen of the area and they want them killed. The whole area around Nanyuki is made up of large ranches and farms. Cattle raising is the big business here and most of the country is divided up into blocks of about 1000 acres which are fenced off to keep the cattle from straying. The antelope eat the grass, which is not all too plentiful. They've had little rain in the last two years and it takes about 50 acres to feed one steer.

One of the ranches (15,000 acres) recently sold for $90,000, to give you an idea of land values. The rancher must continue to improve his land or else the government steps in and takes it away from him, paying him their appraisal, and divides it up among Africans. The ranches still have a good deal of wild game on them and it is mostly a headache. Giraffes and zebras break the fences . . . antelope eat the grass, etc. The owner can go out and exterminate the game, but he must turn the carcasses over to the wild life department. He cannot use the meat or skins or sell any part of it. He gets a little help from hunters, but they are limited in the number of animals they can shoot by their licenses. My license permits me to shoot and eland and an oryx. I could have two impala, two waterbuck, three zebra, and a few other things. I bought a special license to shoot an eland and an oryx. I could have bought a license for elephant, rhino, etc., but I would have had to rent a larger gun and pay stiff license fees for this. Perhaps some other trip.

Larry was now in the shooting seat. Before long we saw a small herd of Tommys and he and his bearer Labun went out after a ram. We heard the shot after a few minutes and drove over and picked up the dead Tommy. A nice one . . . meat on the table for us and a nice skin for Larry.

My turn. We caught a glimpse of some impala. Kerede and I went after them. Kerede stopped and pointed . . . I aimed the gun and looked through the gun scope. All I could see was the rear end of an impala . . . I couldn't even tell if it was a buck. I went back to the car and got my binoculars and took a closer look. It looked like a lousy shot. Larry said he'd like to try it and he took a shot. Nothing.

We lunched in the shade of a larger thorn tree, washing chicken sandwiches down with warm Pepsi . . . tasted good at the time. A whole pineapple for dessert. OK, back to the hunting.

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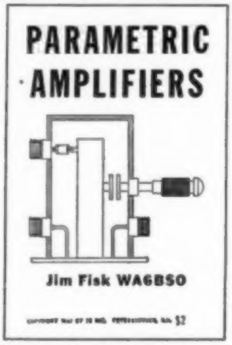

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73 Magazine
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the impala herd again and I stalked them for a bit and saw that I wasn't going to get much closer so I steadied down as best I could and pinged. Miss. Damn.

It was late afternoon before we had another chance. I glimpsed a Grants gazelle off in the woods and Larry went after him. He blasted and the Grant took off. I could see he was hit and in trouble with my glasses. Larry and Labun went after him and Freddy, Kerede and I followed at a distance. We lost them. After about a mile we heard a shot and headed in that direction. Larry had finished him off . . . a very good specimen. Freddy went back and drove the car in to pick up us and the Grant.

It was quite a day. We had dinner at the hotel at 7:30 and went right to bed dead tired.

The next morning, our second day of hunting, I started the day off right by missing an impala buck. Larry got a chance at one a little later and again had to follow to finish him off. Bad luck. It was a fine old buck though with a nice rack. We went back to the hotel for lunch this time, being just about five miles out of town. We set out again at 4:30, when the heat of the day had cooled a bit and the animals would be on the move again. We were looking for impala so naturally everywhere we went we found Tommys. Late in the afternoon we saw some impala about 300 yards away. I got out and got up to about 250 yards when I spotted a tremendous buck. He was magnificent. I could see that he was about to spook so I steadied my gun on a fence post and took careful aim . . . just as I went to shoot he turned and left. Labun and I went after him for about a mile and I never had much of a shot at him. Finally, I popped one off in desperation at over 200 yards, but it was an obvious miss.

We drove into another ranch and some more impala turned up. Larry went with Labun after them and soon we heard a shot. I grabbed my telephoto camera and followed. I came upon them about 100 yards in the woods and Freddy gave me the gun and pointed to the impala herd still standing about 200 yards away. Labun went with me and soon I took aim at the buck he pointed out. He went down immediately and we found that my shot had hit him right in the heart. He was about 100 yards away. He didn't have as nice a rack as the one Larry shot so I decided to keep his skin, which was gorgeous. We also took the meat back to have for dinner. It was delicious.

The next morning I tried again for that big impala and failed to get near enough. Later on we were driving through some rather open woods when a nice group of impala spooked. Kerede and I followed them and as we were closing in there on my left was a huge animal. I didn't have any idea what it was. At first I thought it was a Brahma bull, but the horns were wrong . . . and Kerede was telling me to shoot it. I aimed carefully and plonked him in the shoulder. He keeled over immediately, to my amazement. It wasn't until after the picture taking and excitement were over that I learned that I had polished off a near record waterbuck. He was too big to load in the car so they chopped him in half.

This was such a big trophy that it put a damper on the shooting and we spent the rest of the day sightseeing and taking pictures. We saw lots of ostriches, pelicans, secretary birds, and even giraffes.

The next day we drove out in a different direction and drove about 150 miles sightseeing. The country was fabulous and we saw baboons, lots of Tommys, Grants, impala, dik dik and even a small herd of eland. I was still off shooting so we just looked and clicked. We met a rancher there, a wonderfully interesting man, married to an African wife. He was just coming back from checking his herd of sheep. He has to sleep with the herd every night to keep Africans from stealing them. I wondered why he didn't hire a herder (government standard wage for herders is $20 a month plus food), but found that herders are OK for protecting the sheep against normal problems, but when rustlers show up they frequently strike a bargain with them and off go a bunch of sheep. So Jack sleeps with his sheep.

So far we had been hunting entirely on private lands. You have to reserve public lands considerably ahead of time if you want to hunt them and, despite his promises to do so, Shamsu hadn't reserved any hunting blocks for us. Fortunately Freddy had a good friend hunting in nearby Block 67 and he got permission for us to go in there and pop a zebra or oryx. Thursday morning we started out for 67. It was about a 40-mile drive to the check-in gate . . . then a few more miles to a little village of Ndorodor where we stopped and bought some candy and cigarettes to trade for photographs of natives. A local entrepreneur who called himself Lamumba took charge and got several of the local girls lined up for photographs, standing benignly behind them with his fly whisk. He could speak enough English to get by and we shelled out a shilling (14¢) each to the girls and a Polaroid photo for him. He wanted a dollar too, but we shoved off.

We were in Masai country now and every now and then we would pass one with a spear in hand, paint on his face, and interesting things hanging from his stretched earlobes.

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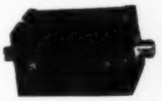

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Then we came to the escarpment. Here the plains at 6000 feet dropped off suddenly to about 3000 feet. The road wound itself down the face and it got hotter and hotter. This was more like the equator. We got to the bottom and found ourselves in very warm desert country. There were some fellows working on the road with Caterpillar tractors. One of them thumbed a ride with us about a mile from the bottom of the escarpment to a thorn enclosed camp about a mile away where police were staying. It seems there is a small war going on in northern Kenya. The Shifta, a nomadic tribe of about 250,000 living on the border of Somalia, didn't mind being ruled by the British, but object strenuously to being ruled by the Kenya government. The result is that they have been fighting a guerrilla war for the last two years. Apparently the communists have been supporting them and the fight has expanded well down into the northern frontier of Kenya.

We drove through the desert, seeing little animal life. There were huge mounds of elephant droppings, but at this time of day they were off in the surrounding hills to keep cool. A herd of oryx spooked as we came around a corner. I went off after them with Kerede and Freddy, but after fifteen minutes we saw it would be a long track and turned back. We had a nice lunch on the bank of the Kipsing river. The river was about ten inches wide with a dry-wash of about 50 feet or so. There were footprints from elephant, rhino and just about everything else imaginable.

It was getting late in the afternoon so we headed back. The trip up the escarpment was a dilly. The Land Rover had to go in its lowest gear with all four wheels engaged to make it in many places. Little else could possibly get up there. As we went through Ndorodor again Lamumba flagged us down and asked us to take him and his wife to Nanyuki. No. But his child is sick and must get to the hospital. OK, we'll take them to the hospital, but no place else. So he loaded his wife and two children in the back of the car and jammed himself in the back seat beside Jim, whisking him a few times with his fly whisk. He smelled pretty boozy, among other things. When we arrived in Nanyuki he lost his command of English and Swahili and could understand nothing we said. He did communicate that he wanted to get off at the Butcher and Tea Room, the local drinking place. We obliged and Freddy again vowed never to give another ride to anyone, no matter what.

We learned the next morning that the Shifta

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had struck at the foot of the escarpment, right where we had been, about an hour after our passing and six men were killed and three wounded. That was a close call.

By Friday our bloodthirst was back and we set out for more hunting. I started the day out right by walloping a nice impala. It was a very good shot and, when we took him apart, found that the bullet had exploded his heart. Even so he made it about fifty yards before dropping and I was afraid I had just wounded him. The shot was about 100 yards. I have to admit that I muffed an impala earlier though. I thought I was dead on him and the bullet whacked as if it was a hit. The impala just stood there so I was sure it was a hit and he would fall down or else I would have shot him again immediately. Then he wandered off and I pinged another after him, missing again. There was a nice hole in the tree just behind him, the whack we heard. You can usually tell, even from quite far off, if a shot is a hit.

Baron Von Scheken, one of the most progressive farmers and ranchers in this area, was most anxious to have us bop some of the zebra that are breaking his fences so he drove out with us in his Rover to show us where the herd was at the moment. Larry and Labun took off on a long stalk with Freddy backing him up in case of a wounded animal. They must have been gone almost two hours before the shot came. No whack, so it was a miss. They came back to the car and we headed off to try to find them again. Suddenly we came on a herd of waterbuck. It was my turn to shoot, but I had my waterbuck so Larry got out again and went with Labun into the woods to circle them and come in downwind. We drove off to allay suspicion. About twenty minutes later came the bang and whack. Good. We drove back but couldn't find either of them. About fifteen minutes later they came in view. It seems that Labun had followed the wrong waterbuck and the one Larry hit was just about 50 yards from where he had killed it, behind a bush. We took pictures in the failing light. It was a fine waterbuck. The Baron was pleased.

On Saturday (today) Larry went out alone while I stayed at the hotel pecking out this brief report. He came back about ten in the morning to announce that he had knocked over two of his three zebras already. I sure hope that I'll get one or two tomorrow when I get out there.

The hunting is enjoyable . . . the weather here is excellent. We need every one of those four blankets at night even though we are on the equator. We'll hunt another week here and then pop on back to Nairobi for a few days, probably visiting the game preserve there

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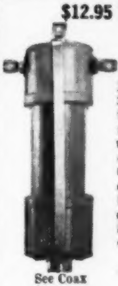
with Robby and then driving down to see the Lake Amboselli game preserve. From there we plan to visit Murchison Falls in Uganda, with a stop at 5Z4JW on the way. Then, if things are calm in the Congo, we will drive over and visit 9Q5HF and 9Q5IA and back into Rwanda to 9X5GG. If things are touchy there we may come back earlier and go on our way to ET, ST, SU, OD, etc.

The time was when a hunting safari to Kenya was a very expensive deal, possible only to the very wealthy. It entailed dozens of men to carry the tents, food, guns, and equipment and weeks in the jungles fighting off heat, bugs, and dysentery. I'll tell you exactly what this whole works cost when I get all done, but right now the basic expenses have been $690 for the three weeks in the hotel plus all hunting costs, though we cut down on this a bit by splitting the total cost for two hunters and one non-hunter ($345), coming out to about $575 each for the three weeks. The gun cost $90, including the license and 140 rounds of ammunition. The hunting license cost me $120, though I could have just as well bought the $57 license if I hadn't included the right to shoot on public lands and the special orxy and eland permits. I figured that since I don't get to Africa all that often I had better spend the extra and be sure. Larry bought the private land $57 license and has had no problem. They even have cheaper license available if you want to just shoot one each of the plains game . . . and for only $14 you can go out and pop two animals. Something for every pocketbook.

I'll have some expense in getting my trophies prepared and skins tanned and shipped back to the U.S. And add $100 or so for films . . . better make that $200 since I shoot first and ask questions later. And we'll have to budget perhaps $50 each at most for tips for our gun bearers. The whole works is still a fantastic bargain. Of course the fly in the ointment is the air fare over here, which is brutal. It is almost the same as the around-the-world fare . . . it cost me about $200 extra to continue from Kenya on around the world rather than just flying straight back.

I was surprised to find out how few people come to Africa to hunt. I don't know what I imagined, but last year they sold only 480 hunting licenses and this year they hope to break 500. When you consider that the great bulk of the hunting in Africa is taking place in Kenya you can see that few people are involved yet. For that matter there are only 62 fully licensed professional hunters and only about 20 of those make a full time job out of the profession. Eight of the hunters live in



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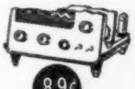

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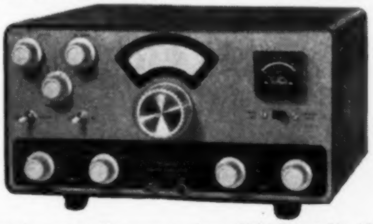

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Nanyuki, so you can see that this is a very popular game area.

Kenya has been self-governed for just two years so far and it is really going quite well considering the enormity of the problems they faced. The total population of Kenya is a little over 10 million of which about one half million are Asian and 50,000 European (white). Few of the Africans have had much education and you might draw a rough parallel if you imagined what would happen to our country if suddenly it were turned over to seven or eight year olds to run. The Africans are just two or three generations from complete tribal savagery and old patterns of living take a while to change. The change has been tremendous already, but there is a long way to go.

I find just about everyone here optimistic about the future of Kenya. Freddy wants to start an animal farm similar to some very successful ones down in Rhodesia and run a sort of dude ranch affair with horses and camels, camping expeditions and plains game hunting for those interested right on his ranch to keep the animals under control. It's a new approach and I'll bet it would work. If the supersonic planes bring down air fares Kenya will be crowded with tourists.

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Zener Diodes

This excellent article explains how zeners work, how to use them, how to test them, and how to buy them. It's another of 73's technical feature articles.

One of the many solid-state devices now available to the radio amateur builder is the zener diode. Properly used, it serves as a reference voltage source capable of delivering considerable current. Unlike a battery, its life is indefinitely long, although it must be supplied with a continuous current for many of its applications. This article contains the basic information required to intelligently design and use zener diodes, and some selected sources of information from the rather sparse supply are listed in a bibliography at the end.

For instance

The number one application of zener diodes is probably dc voltage regulation for transistor circuits Suppose you have just purchased a new 1N2974 zener for about $5.10. The catalog says 10 watts, 10 volts, 20% tolerance. Since you lack experience with zeners, you breadboard the intended circuit to pick up a few details on what zener regulators do. Perhaps the circuit is that of **Fig. 1.** Careful! The illustrated circuit is more suited to my purposes than yours! You turn it on and this might be what happens:

A voltage measurement reveals regulation at 8.5 volts rather than the indicated 10 volts. You notice the voltage seems to be creeping up as you watch the meter. A signal tracer probe on point A finds lots of hum; but there is some at B too. Perhaps if some current is drawn from B the hum will decrease. A load test shows little effect on the hum except that under very heavy load the hum increases . . . some other noise too! Thinking about that, you smell smoke; it's the series resistor overheating. As you reach over to turn off the power supply, you notice the zener voltage seems to have dropped to zero. This reminds you that the zener has been operating without a heat sink. It's failed completely! Terrible. You can avoid the damage to wallet and peace of mind by using the following material. After reading, get out a pencil and some old envelopes or something, and design zener circuits. You'll soon catch the idea!

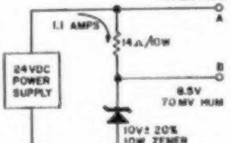

Fig. 1. A possible hit-or-miss zener regulator circuit. What's wrong with it?

Zener facts

Zener diodes are supplied in a large variety of packages. The controlling factor is how much heat must be dissipated. A majority of the zeners available are supplied in a diode-like glass package for up to 250 milliwatts, a wire-mounted cylinder resembling a resistor or a silicon rectifier for the 1-watt size, a stud-mounting package for the 10-watt size, and a larger package resembling a power transistor for the 50-watt size.

A catalog search brought out hundreds of zeners rated from 250 milliwatts to 50 watts. Some engineering books mention zeners as small as 50 milliwatts (Cutler) to as large as 100 watts (Littauer). Operating voltages ranged from 3 volts to 200 or so. The least expensive were priced at 75 cents (General Electric Z4XL series). $20 seemed to be the upper limit, with a large variety in the $4-$7 range. Price tends to increase with higher power rating and closer tolerance, but some good zeners are available in epoxy packages at low prices.

Some ordinary silicon diodes and transistors may be used as zeners.[1] General Electric says some of their epoxy cased transistors can be used in this way. But most zeners are slightly special silicon diodes, designed to dissipate the fairly large amounts of heat produced in normal zener operation. Small zeners dissipate the heat along their leads or into the air; 10 watt and larger zeners are built like power transistors. The semiconductor material is brazed to a copper stud or surface which provides the route for dissipating excess heat into the required heat sink. **Fig. 2** shows some typical zeners.

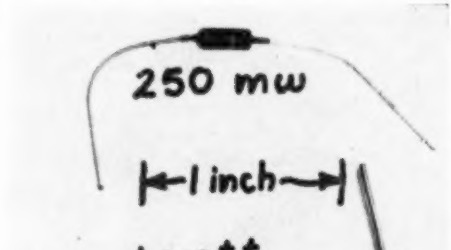

Fig. 2. Some typical zener diodes. They look just like ordinary diodes. Perhaps some of your diodes are zener diodes!

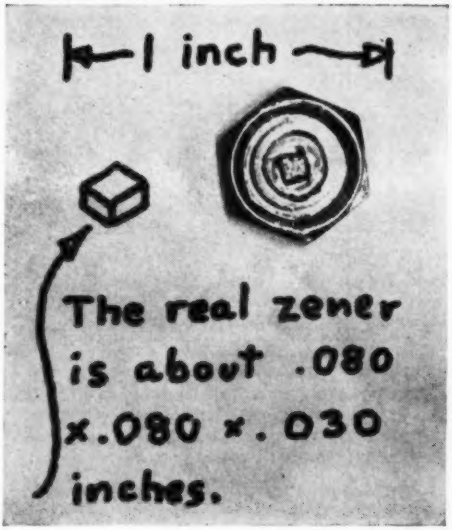

Fig. 3. Inside the case of a 10-watt zener. The actual PN junction is in the tiny square at the center of the circle.

Only a small part of the package called a zener diode is actually the working element. This key piece is a semiconductor PN junction formed on a silicon wafer by a process involving some heat and considerable accuracy. **Fig. 3** shows the interior of a 10 watt zener. In normal zener operation the PN junction is biased opposite to the direction of easy conduction, at a voltage great enough so it conducts anyway. Sounds rough, but works fine. The arrangement is called reverse bias, and the zener always appears in the schematic with its arrow pointing toward the positive supply line. **Fig. 4** is a graph of current plotted against voltage for normal zener operation.

A small voltage invokes very little current. As the voltages approaches 10 volts, the current increases quite drastically toward some terrific value as the zener begins to act like a short circuit. If there is no current-limiting resistance in the circuit, the zener will promptly perish. This very rapid current upon voltage dependence gives the zener its useful voltage regulating property. The region of the

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[1] See K9VXL's article, "Save That Transistor!" in the July 73.

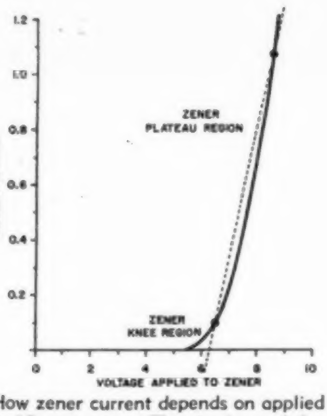


Fig. 4. How zener current depends on applied voltage for a 10 watt zener. The rise beyond the knee is so sharp the zener must be supplied from a current-limiting resistor or circuit.

curve in which the current first begins to rise is called the zener knee, and the normal operating region is called the zener plateau. The useful plateau is limited at one extreme by the current required to keep the zener action alive, and at the other by temperature increase sufficient to destroy the zener.

The zener regulating voltage depends on how thick the PN junction is. If the PN junction is very narrow, the zener will regulate at a low voltage; we leave these details to the manufacturer. But depending on the structure of the zener it may show an increase or a decrease of voltage as it gets warmer! Zeners under about 5 volts will show a decrease in voltage, over about 5 volts a rise, with increasing temperature. A happy choice of voltage and current will give a zero drift: 40 mA at 4.8 volts, to 3 mA at 6 volts. Review the manufacturer's specs if real stability is required. Two or more zeners in series will show a smaller temperature voltage drift than a single equivalent higher-voltage zener.

Type	Price	Nom. Voltage Test Current	Watts	Tolerance	Dynamic Resistance in Ohms
1N4728A	$1.93	3.3@76 mA	1	5%	10
1N4733A	1.93	5.1@49 mA	1	5%	7
1N4735A	1.93	6.2@41 mA	1	5%	2
1N4739A	1.93	9.1@28 mA	1	5%	5
1N4747A	1.93	20@12.5 mA	1	5%	22
1N4752A	1.93	33@7.5 mA	1	5%	4.5
1N957B	2.95	6.8@18.5 mA	0.5	5%	4.5
1N3016B	3.70	6.8@37 mA	1	5%	3.5
1N2970B	7.30	6.8@370 mA	10	5%	1.2
1N2804B	10.65	6.8@1.85 A	50	5%	0.2
Z4XL6.2	0.75	6.2@20 mA	1	20%	9
Z4XL6.2B	0.84	6.2@20 mA	1	10%	9

Fig. 5. Types, prices, and characteristics of some typical zeners. Note variations in dynamic resistance.

Zener specifications

All zeners are supplied with a voltage rating, and a tolerance. Like resistors, the standard tolerances are 20%, 10%, and 5%. The nominal values are usually chosen in the same way as those for resistors, resulting in voltage ratings that should sound very familiar. The system is based on the twelfth root of ten for 10% zeners, so you will find for instance, 3.3, 3.9, 4.7, 5.6, etc., voltage ratings. **Fig. 5** lists some zeners and their properties. If you are trying to regulate to a critical voltage, a germanium or a silicon diode may be placed in series with the zener (small increment) or in series with the load (small decrement).

The temperature drift problem can be minimized by keeping the zener cool. This conflicts with power handling ability but tends to guarantee long life despite experimental accidents. Like all semiconductor materials, if a zener PN junction gets too hot, the doping atoms begin to jump into new sites. This is very bad for the zener! Since the junction may withstand temperatures as high as 200 degrees Centigrade, zeners are not remarkably fragile. But they cannot withstand the kind of overload even small power supplies can produce.

Zener wattage, as in any resistor, equals voltage across the zener times current through the zener. Check manufacturer's specs if much power is to be handled or if operating near maximum ratings. For breadboard and quick-and-dirty construction the fingertip test will do: too hot for a five-second fingertip touch equals too hot.

The zener's ability to stabilize and filter a power supply output is indicated by its dynamic resistance. Low dynamic resistance is desirable. Suppose you wish to have power supply output stay within one-tenth volt of nominal in spite of 100 mA variations in current. By Ohm's law that works out to one ohm: this is the dynamic resistance required. High wattage zeners, near 6 volts, have better dynamic resistance than any others; high voltage zeners have very poor dynamic resistance but are not required for most semiconductor

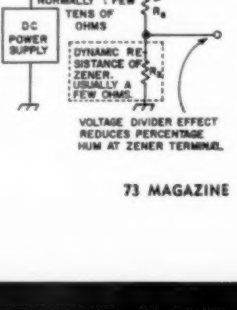

POWER SUPPLY HUM VOLTAGE MEASURED HERE
CURRENT LIMITING SERIES RESISTOR. NORMALLY A FEW TENS OF OHMS
R_s
DC POWER SUPPLY
DYNAMIC RESISTANCE OF ZENER. USUALLY A FEW OHMS.
R_z
VOLTAGE DIVIDER EFFECT REDUCES PERCENTAGE HUM AT ZENER TERMINAL

Fig. 6. Equivalent circuit for estimating how much a zener regulator will reduce the percentage and amplitude of power-supply hum.

circuits.

The practical effects of dynamic resistance can be brought out by drawing equivalent circuits to show what's involved. An equivalent circuit is something used by engineers to simplify circuit problems. The dotted box suggests "we imagine the actual device acts like what's in there." From a hum viewpoint, the zener improves the situation as if the entire circuit were a voltage divider. The upper resistor is the required series resistor R_s and the lower resistor is the zener's dynamic resistance. This is usually listed in the catalog entry. If the dynamic resistance is one ohm, and the series resistor is fifteen ohms, the usual way of working out voltage-divider circuits tells us the hum will be reduced by a factor of 16. That doesn't remove it! Typical hum from a capacitor filter low-voltage supply is a half volt to three volts. This would result in anticipated hum figures 30 to 200 mV; still plenty of hum.

Fig. 7 shows the way to estimate how much the zener voltage will change under load. This figure is very different from the actual circuit so do not feel stupid if it's not clear! Try this with an actual zener when you've finished the article. Measure the zener voltage at a current near the knee. Measure it again at near maximum zener current. It will be higher. Now write down that higher voltage next to the 'inside battery.' If you draw current from this equivalent circuit, the voltage will drop because of losses across the inside resistor. This is just what the real zener circuit did: the small zener current corresponds to maximum load condition from the equivalent circuit. The voltage change divided by the current change gives the value of the series resistor. It will be the dynamic resistance again. This shows that knowing the dynamic resistance is very useful in reckoning the effects on regulated voltage of changes in load current.

Zener noise

The useful ability of zeners to control circuit hum and noise is somewhat compromised by their natural ability to generate signals of their own. The zener regulating process is like an electrical discharge, and can produce similar noise. Good zeners produce very little noise, but some may become quite loud in the zener knee region. If your new circuit seems to be troubled by erratic frying and hissing noises, and this is traced to the zener regulator; the two solutions are increasing zener current to keep it out of the knee region, or the addition of a capacitor to take up the noise. Try 0.1 μF to start.

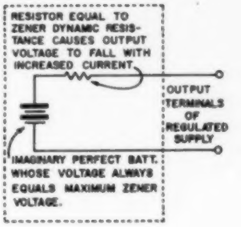

RESISTOR EQUAL TO ZENER DYNAMIC RESISTANCE CAUSES OUTPUT VOLTAGE TO FALL WITH INCREASED CURRENT.
OUTPUT TERMINALS OF REGULATED SUPPLY
IMAGINARY PERFECT BATT. WHOSE VOLTAGE ALWAYS EQUALS MAXIMUM ZENER VOLTAGE.

Fig. 7. Equivalent circuit for reckoning voltage drop with increased loading of a zener regulated supply.

Varactors are reverse-biased silicon diodes. Since zeners are also reverse-biased silicon diodes, do they have an associated capacitance? They certainly do; it may be as large at .01 μF. This capacitance is unimportant in normal operation, and probably has a beneficial effect in reducing zener impedance at high frequencies. Perhaps this capacitance can be put to other uses! Might be an easy way to double up to 40 from 80 meters. Another possible application would be oscillator tuning; perhaps a cheap zener would work better than a cheap silicon diode. All this brings to mind Fisk's interesting article in the March 1966 issue of 73.

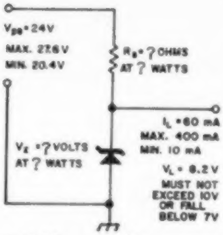
Zener regulator design

All zener circuit designs depend on the same basic facts of the zener's voltage, tolerance, wattage rating, dynamic impedance, and perhaps temperature drift. The worst case from the zener's viewpoint is DC power regulation, with a steady current supply from a voltage source capable of destroying the zener if the series resistor fails or is shorted. Zener regulators are very useful and deserve a close examination.

Only professional engineers should design zener circuits to operate at the limits of the zener's capabilities. The amateur, by leaving generous margin for error, can simplify the design problem to a point where only the simplest math and less than complete information on the zener's capabilities will be sufficient for a reliable design. Apart from possibly very serious misunderstandings on the amateur's part, the major troubles that might arise are the relatively generous tolerances on most inexpensive zeners, the wattage problem, and voltage change under load resulting from dynamic resistance.

The design process commences with finding some working figures. Refer to **Fig. 8**, a design sketch made just before carrying out the following procedure. Power supply voltage, zener voltage, and load current information are collected, along with their estimated maximum and minimum values. A class B audio ampli-

Fig. 8. Designing a reliable zener regulator. The question marks indicate values to be worked out.



fier of a few watts capability could account for the fairly large current variations shown in the diagram; this is a rather extreme case. But it could happen! If the load were a receiver small-signal circuit, an oscillator, or a transmitter VFO; the load would be practically constant. After collecting this information from figures, estimates, educated guesses, and by breadboarding, the circuit is designed on average values. When a series resistor and a zener are chosen, their anticipated properties are checked against possible extreme conditions of voltage and amperage.

Variations in load current are made up by opposite variations in zener current. Minimum zener current flows when maximum load current is taken from the regulator. This adds up to the first requirement for the zener: it must carry a current greater than the anticipated load swing. The regulation fails if the zener is starved into the knee region, and if the zener is overheated by excessive current, catastrophe is likely. Often a well-placed large capacitor in the load circuit will absorb the drastic swings. The zener required in **Fig. 8** must carry more than the swing of 390 mA. If the minimum and maximum loads were both greater by 1 A, the swing would remain the same and so the zener minimum current requirements would be unchanged. However, with increasing loads flowing past the zener, a point may come at which turn-on or turn-off of the circuit results in transient overloading of the zener.

A safe minimum zener current is 10% of its maximum rating. A fresh zener accompanied by manufacturer's specs may be used at much lower levels, taking the specs as a reliable guide. For surplus zeners the 10% lower limit is recommended unless a test shows the particular zener will stand further starvation. Since the voltage requirements are already determined, the choice is made on the basis of wattage. Don't be afraid to use an oversize zener; it's safer and the larger zener will have a lower dynamic resistance. The absolute minimum wattage required equals the maximum possible voltage across the zener times the maximum expected current through it. There seem to be no 5 watt zeners; for most regulator purposes the choice is limited to 1 or 10 watts. Or 50 watts if you wallet can stand the drain. The zener in **Fig. 8** should carry about 450 mA under minimum-load conditions; at 9 volts that works out to just under 4.5 watts. A 10-watt zener is indicated.

Now the series resistor R_s can be chosen. The voltage at its upper end is fixed by the power supply, and at its lower end by the zener. The series current is the maximum load current plus the minimum zener current finally decided on . . . in the case of **Fig. 8** this was a total of 450 mA. This same current flows if the load drops to 10 mA, since the zener now takes 440 mA. Knowing the voltage across the resistor, 24 volts minus 8.2 volts, or 15.8 volts, it appears that a resistance of 35 ohms and about 7 watts is the minimum value.

This leaves no margin for error. A better choice is an Ohmite adjustable wire-wound resistor, 50 ohms, 25 watts. More than half the resistor will be in the circuit. If only half or 25 ohms were used, it would still be rated at 12.5 watts, so that with this choice the success of the design seems probable.

Now we return to the zener. Any electrical slop in the design can be taken up by the resistor, and we know that a 10-watt zener is required. Referring to the catalog, we find a 1N2973B, 9.1 volt 5% zener. We expect the circuit can withstand the possibly slightly high voltage. If not, we'll change the circuit. We choose a zener at the high end of the range because its voltage will drop under load: a dynamic resistance of 2 ohms means 2 volts drop per amp decrease in zener current, or in the case of **Fig. 8** the voltage will swing over a range of 0.23 volts. Adding to this the .45 volts possible error due to zener tolerance, and adding that to the 9.1 nominal zener rating gives about 9.8 volts as the largest we should expect to see in the circuit. Subtracting the same figure from the 9.1 nominal figure gives a minimum of 8.4 volts in the case of an extremely low valued zener. These results are within the previously decided requirements.

There is still the question of changes in power supply voltage. What happens if line voltage changes drastically? This cannot be answered simply; some line voltages are more changeable than others! In **Fig. 8** a 10% variation either way was just picked out of the air. This is probably large. Now if the zener voltage is fixed at 10 volts, which it will never quite reach in the actual circuit, and if the supply voltage drops to 20.4 volts; the series resistor being at 35 ohms with 10.4 volts across it now passes only 335 mA. Not enough, so we adjust the resistor to 23 ohms, and it now passes 450 mA. But now we must try the other extreme: the power supply voltage rises to 27.6 volts and we suppose the zener to be an 8.4 volt type. Then we find 19.2 volts across a 23 ohm resistor. That is about 840 mA. The zener won't overheat if it is properly mounted, but the resistor must dissipate 16 watts. Since less than half of it is carrying current, we must go to a smaller resistance at the same wattage in order to get enough dissipating surface. The choice is a 25 ohm 25 watt resistor, still adjustable. Or if you're a little apprehensive about going that close to the limit, a 50 ohm 50 watt resistor can be purchased at an 83 cent increase in price.

That completes the design. This process avoids the following kinds of grief: Zener failure due to overheating; zener voltage out of specs; circuit loads zener regulator into the knee region; regulator fails due to starvation or overheating at extreme line voltage values.

Correcting zener voltage

The combined effects of high prices and large tolerances are hard to beat! But a resourceful amateur need not lose a project just because his nearest zener isn't quite near enough. Zener voltage can be adjusted up or down by correct use of small germanium or silicon diodes. The price is a slight increase in dynamic resistance and in temperature drift. Some knowledge of the properties of forward-biased diodes is required.

A silicon or germanium junction diode, carrying a forward current of 10 to 100 mA, depending on its size, has properties very like those of a low-voltage zener. In fact, there are no zeners under about three volts, and diodes are used in just this way to fill the remaining gap down to near zero. Beyond the early stages of conduction, a few microamps or mils, the diode voltage changes very little with current. Its dynamic resistance is quite low. Diodes can be used in zener circuits as if they are little batteries, to achieve a slight increase or decrease in apparent zener voltage. The voltage measured across the zener itself is not affected.

The voltage at which the diode regulates depends on its material: germanium or silicon. A germanium diode well into conduction will show a stable voltage of around 0.3 volts; a silicon diode regulates above 0.7 volts. A transistor base-emitter or base-collector junction could be used in place of the real diode; it's a PN junction too and will show the same behavior.

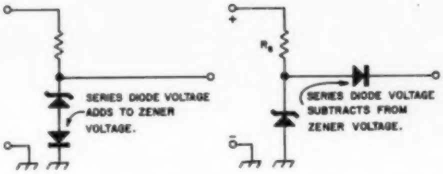

SERIES DIODE VOLTAGE ADDS TO ZENER VOLTAGE.
+
R_s
-
SERIES DIODE VOLTAGE SUBTRACTS FROM ZENER VOLTAGE.

Fig. 9. The effective regulating voltage can be adjusted by correct application of ordinary germanium or silicon diodes.

To achieve a small increase, the diode is placed in series with the zener, as shown in **Fig. 9A.** The reverse-biased zener and the forward-biased diode point in opposite directions. The drawing is arranged so that positive current—a convention—flows down. **Fig. 9B** shows the diode in series with the load, so that its voltage subtracts from the zener voltage. They seem to be pointed in the same direction, but the current flows against the zener and with the diode. This is certainly confusing and will require some careful thinking. Try it; make your mistakes on a breadboard where they show clearly and are inexpensively remedied!

Amplified zeners

Being relatively high priced and having rather large tolerances, zeners may seem rather useless to many amateurs. But a small, inexpensive zener can be combined with a transistor, making a simple two-terminal circuit that will stand in very well indeed for a 50-watt or even larger zener. This particular transaction shows an unusual measure of profit: besides greatly reduced price and substantial easing of power limitations, dynamic resistance may be improved and becomes little affected by using diodes in series with the zener to build up its voltage. The effects of temperature upon voltage are increased but this will rarely be important. The current handling ability is multiplied by the transistor β, but the temperature drift is only that of the individual diodes in series.

For instance, a Texas Instruments 2N251A at $2.25 plus a General Electric Z4XL6.2 at 75¢ adds up to $3.00 for a shiny new, somewhat adjustable zener, rated about 50 watts depending on the beta of the transistor. This is comparable to the 1N2804B, priced at

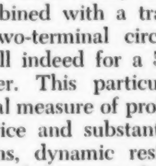


Fig. 10. Schematic of an amplified zener. It's all there!

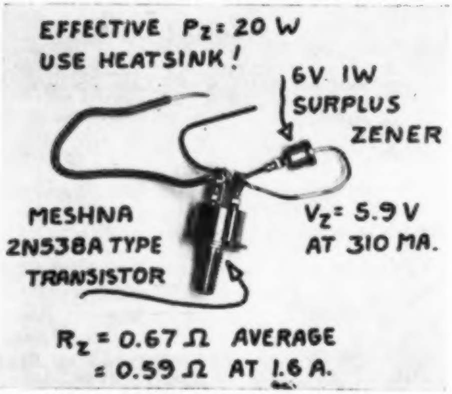


Fig. 11. A real amplified zener, and its measured characteristics. This one is good for about 20 watts. Made of junk box parts, its estimated cost is 50¢.

$10.65. That's what makes amplified zeners interesting!

The complete circuit is shown in **Fig. 10.** It does seem rather bare in comparison with most transistor circuits, but everything that's really required is there: one zener and one transistor. This two-terminal circuit closely resembles the emitter follower regulator, and if a resistor were added from the zener diode/transistor base connection up to a higher voltage to ensure liberal zener current, it would be an emitter follower regulator. But the resistor can be omitted if the amplified zener's knee region is avoided, and then the current divides between the transistor and the zener according to the beta of the transistor.

An amplified zener is shown in **Fig. 11.** This one costs an estimated 50¢ and gives very good test results. Its knee region seems to end at about 4.2 mA and the actual zener diode is not overheating at 1.6 amps regulator current. A current increase to about 1.6 amps boosts the voltage from 5.6 to 6.8 volts, for an average dynamic resistance of 0.67 ohms. Using the voltage-divider method and hum input-output measurements, its dynamic resistance at 1.6 amps is 0.59 ohms. The very best zeners are little better than that. There is one hidden pitfall: the transistor's leakage current increases with temperature. This extends the knee region to higher current values.

This is how the current division works out. There are only two terminals; the current must go in one and out the other. It takes two routes in between. Suppose the base-collector zener is carrying m milliamperes. The transistor base-emitter junction supplies this current, and as a result an additional current, β times larger, flows from emitter to collector of the transistor. The total current I is the sum of these two, so that we write

$$I = m + \beta m = m\ (1 + \beta)$$

The one plus beta in the parentheses is not particularly different if we leave out the one, provided the beta is greater than ten or twenty. It usually is in a usable transistor; the difference between ten and eleven is 10%, small by electronic standards. For most purposes it's simpler yet true enough to say all of I goes through the transistor, the circuit regulates at the zener voltage plus the transistor BE voltage, and the zener heating current is I divided by β. The error is trivial.

For example, the Z4XL6.2 is rated at one watt, the 2N251A at 90 watts, and suppose a β measurement under approximate operating conditions gives a result of 50, well within specs. Remember that β is quite evanescent, depending upon collector current in addition to great variations between transistors of the same type! The maximum allowable zener current is 160 mA, since .160 amps times 6.2 volts equals the rated one watt. Then 50 times 160 mA gives a maximum of 8.4 amps current. The amplified zener regulates at 6.4 volts, since the live germanium transistor will show about 0.2 volts from base up to the emitter which is added to the zener voltage. If you really want to dissipate 50 watts, the transistor should have higher β or a 10-watt zener should be used; stay away from calculated limits!

The dynamic resistance of the amplified zener will be the inside real zener's dynamic resistance divided by the transistor β. This works out to one-fiftieth of 9 ohms: 0.18 ohms. This value is so low that the power transistor's characteristics may enter into the final result; the final value will still be well under an ohm. This result is not appreciably spoiled by adding series diodes to pad up the zener's apparent voltage.

As the current through the amplified zener is reduced toward zero, the real zener and the power transistor both weaken. The combined effects are rather uncertain, so that bread-

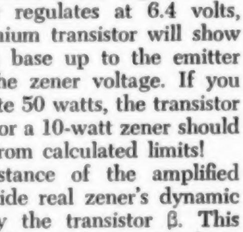


Fig. 12. A pair of zeners in series to provide both positive and negative voltages with respect to circuit ground, using a single power supply.

boarding with the actual components is a good, safe practice. Find the knee by measurement; remember that a capacitor across the zener will reduce its noise generating capabilities! A 6 μF electrolytic capacitor eliminated a rushing noise near the knee region in the amplified zener shown in **Fig. 11.**

Other zener applications

Zeners do not go very well in parallel. One will tend to hog the current. There is no need for parallel zeners anyway; an amplified zener will do a better job. But zeners can be connected in series to provide two or more regulated voltages. And in this case the ground can be between the zeners, rather than at one end of the power supply. If you ground both points, it won't work!

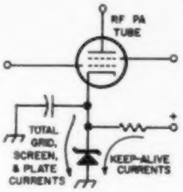
The design of switching circuits is considerably simplified if the usual collector voltage supply is supplemented by a lesser voltage of opposite polarity. The second supply is used to drain off unwanted leakage currents, turn diodes and transistors hard off, and for other applications. This relatively slight increase in the designer's armament eases many tough circuit problems. By using a pair of zeners in series, the desirable pair of voltages can often be obtained without going to the time and expense of a separate second power supply and all its problems of cost, space, weight and regulation. **Fig. 12** shows how simple this arrangement is.

Without a load circuit, the same current flows through both zeners. If some current is side-tracked around either zener, the voltage across it remains constant. The regulation isn't disturbed at all if some current is taken out around both zeners, and this is the normal application. The usual considerations about starving and overfeeding zeners are applicable here, and the beginning designer should remember that the two supply circuits don't necessarily require the same currents at the same time.

The zener diode shows little promise as a limiter and no schematic for this application is included. Ordinary diodes are distinctly superior. Zeners require too high voltage: 3 volts or more. In normal circuits that's in the high-power range. The clipping should be carried out well before the signal gets this large. Also, the zener will clip at normal silicon diode levels as soon as its PN junction is forward biased. Additional diodes would be required to prevent this, unless unsymmetrical clipping were intended. Zener clipper circuits appear impractical.

The only remaining field in which vacuum tubes retain some superiority to solid-state amplifiers is large-signal rf power amplification. The zener diode can fill a very useful spot here. It can replace the cathode bias resistor, offering a bias voltage quite independent of tube current. **Fig. 13** shows a zener in this application.

Fig. 13. Zener diode biasing for an RF power vacuum tube. Bypass capacitor recommended, appropriate for operating frequency.



Because the zener acts like a battery, most of the high voltage is taken up by the vacuum tube. The zener merely guarantees the bias. It never runs down or emits corrosive chemicals, and has a lower internal resistance than the batteries used for this application in the old gear described just after WW2. If the tube is to be biased to cutoff, the zener can be supplied with enough current to keep out of its knee region by means of a resistor up to the high voltage or over to the adjacent transistor circuit which should be providing the rf to the power amplifier. The zener should be bypassed for rf.

Zener meter

A zener diode can be wedded to a meter circuit with very useful results. To understand the utility of this match look at the usual linear meter scale. Suppose it reads to 20 volts. A one-volt reading will be way down at one end, and a lower range is required to make it readable. A small change huge percentage increase at the low end equals in scale space a small change tiny percentage increase at the high end. That's not a very equitable distribu-

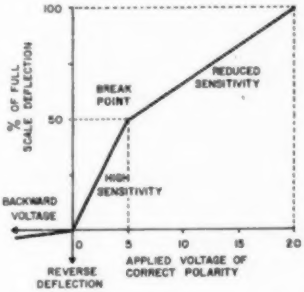


Fig. 14. How an improved meter might be calibrated to show small and large voltages with comparable accuracy. Reverse voltage does not bang the needle backward.

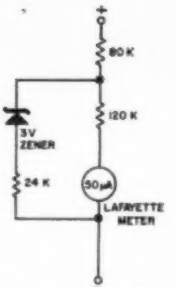


Fig. 15. A circuit that will produce the characteristics shown.

tion! For example, it would be convenient to check transistor emitter-base and emitter-collector voltages without changing ranges.

The required benefit is achieved if the circuit can be made to show variable meter sensitivity. **Fig. 14** shows a realizable result, detailed below. The first half of the meter scale is taken up with the zero-to-five volts range. The five-to-twenty volts range occupies the second half of the scale, without switching. The poor sensitivity to voltage applied in the wrong direction is a valuable by-product of scale tailoring with a zener diode.

At first glance this circuit appears to have been designed by a network expert. A closer look reveals that the values of the resistors may be deduced, one at a time, by thinking out the inside requirements of the circuit. R1 and R2 will fall first. If the meter is to read 5 volts at half scale with 5 volts applied, R1 plus R2 must come to 200kΩ since this will pass the required 25 microamps. The Lafayette meter's resistance of 1kΩ is insignificant in comparison to this value. Supposing at 5 volts the zener hasn't quite broken down, it must have just 3 volts across it. The voltage across R1 must be 2 volts, and at 25 microamps the resistance must be 80kΩ. That leaves 120kΩ for R2 since the pair must add up to 200kΩ. We already know the zener; the problem is two-thirds solved.

Now we proceed confidently to the determination of R3. At 20 volts applied the meter reads full scale, therefore is carrying 50 microamps. This current through R2 must bring the junction between R1, R2 and the zener to 6 volts. Now there must be 14 volts across R1 and that yields 175 microamps through it. The meter gets 50; 125 microamps pass through the zener and its series resistor. We have it! From the junction through the zener we lost three volts, by design; the remaining three volts at 125 microamps fixes R3 at 24kΩ.

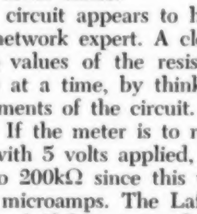


Fig. 16. A zener diode combined with a transistor to make a constant-current regulating circuit.

A breadboard check shows that the circuit behaves about as shown in the graph. This graph preceded the design, and the actual circuit is influenced by the characteristics of the zener in its knee region. Because the zener comes into conduction gradually as applied voltage is increased, rather than abruptly, the actual scale change from steep to flatter occurs along a rounded curve. A new calibration scale must be constructed empirically. That is, each point must be located by applying the indicated voltage and marking or listing the resulting meter deflection. This good idea needs further development; it requires enough current to disturb many transistor circuits.

The constant-current generator circuit closely resembles the amplified zener. Only a resistor has been added. But the constant current generator guarantees a certain fixed current, rather than the amplified zener's reliable voltage. Its operation depends on the resistor; the zener provides a reference voltage and the transistor, acting as an emitter follower, holds that voltage across the resistor. The resulting current, determined by Ohm's law, is independent of voltages applied to the outside circuit terminals if the transistor is biased into its operating range.

A working circuit is shown in **Fig. 16.** Remember that the power dissipated by the transistor is determined by its collector current and voltage, not by the values at the rest of the circuit. As in the amplified zener, if the transistor β is large enough the zener current may be ignored. The computation proceeds in this way: the 6 volt zener fixes the voltage across the resistor at 5.8 volts, because 0.2 volts is lost across the base-emitter junction of the germanium transistor. If a silicon transistor were used, the resistor would see 5.3 volts. Since a current of 100 mA is to be guaranteed, the resistor must therefore be 58 ohms. A fixed current of 10 mA would require a 580 ohm resistor since the voltage across it is held constant. But that might not work so well since the zener could be starved for current; perhaps the zener could be biased elsewhere and its voltage carried over to the transistor base.

This is an excellent circuit for eliminating hum. The hum current cannot pass the con-

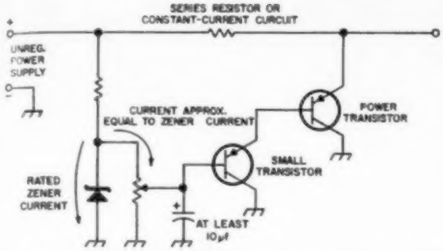


Fig. 17. A very close relative of the amplified zener. Acts like a variable zener.

stant current circuit: no hum! But before this circuit can be put to work in a usable power supply, it must be provided with an appropriate load. The fixed current will generate a large voltage across a large resistor, a smaller voltage across a smaller resistor, and a zero voltage without blowing up anything across a short. This fail-safe feature can be retained while correcting the terrible regulation problem by adding a zener regulator. The constant current is just right for biasing zeners; it is inserted in place of the usual series resistor, and a really good supply results. You should know how to do that by now!

Finally, the last circuit is a realizable substitute for a continuously variable zener. It looks very much like a Darlington pair used as an emitter follower. A current of 10 mA or so from a zener regulator puts a fixed voltage at one end of a pot, decreasing to zero at the ground end. This voltage is stable if very little current is drawn. But the current required by the Darlington pair to regulate at a certain voltage will be the through or zener-like current divided by the β of the first transistor, the result divided again by the β of the second transistor. A milliamp will determine one to ten amps! The illustrated circuit will regulate from about one to 15 volts. The capacitor is required to take out hum coming around through the zener reference voltage source. A supply using the two circuits above shows regulation as good as simple feedback-regulated supplies, combined hum and noise of about 0.6 millivolts, and adjustability over a wide range.

Surplus zeners

Zener diodes are available at prices well under par from several sources. The routes by which these zeners enter the surplus and ham markets are not at all apparent, but it seems that in many cases these zeners are rejects having no place in any electronics gear, amateur or otherwise. It also appears that some suppliers—note plural!—do not test their zeners as well and carefully as advertising statements seem to indicate.

Assorted zeners from one supplier were tested for zener voltage and dynamic resistance. Most tended to regulate in the general 20% region, but a few were drastically off. Many of these zeners, 10 watt stud mounting types priced under a dollar each, had fairly high dynamic resistance. Perhaps that is why they were available! A second collection, about 30 assorted zeners adding up to the attractive price of $10 plus shipping, appeared considerably less economical after careful checking and tests. Some were mounted backwards in their cases, many showed poor regulation, a few were phenomenally noisy, others did not zener at all, and one had a broken lead. The more expensive varieties did not seem to average any better than the cheapest ones. There is a moral here. If you are going to use surplus zeners, check regulating voltage, dynamic resistance, and noise characteristics of each zener before you put it in that nice new circuit. Don't take it on faith; the chances that it is not as indicated may be as bad as one in two.

This experience suggests that the most effective way to buy is to purchase new stock zeners, or else test before buying. It may help to initiate a general practice of testing zeners promptly upon receipt, and returning bad ones to the supplier. Be certain the test is correct! Or perhaps you have found a good source of tested surplus zeners; if so, make the most of it and tell your friends. A zener is a zener, and it's the device, not the label, that is required in the circuit.

Testing surplus zeners

A batch of surplus zeners can be tested most effectively if the operation is performed in several steps. The first pass eliminates the obvious duds, the second sorts out the remaining zeners into broad voltage ranges. A third, perhaps, determines if a particular zener can be used in a specific application.

Several instruments are required for complete testing. Also a few resistors and clip leads, a place to work, some scratch paper, and marking paint. A high-sensitivity multimeter or a dc VTVM serves for voltage measurement. Another multimeter or a milliammeter provides for current measurement. An optional ac VTVM is useful for checking dynamic resistance by the hum voltage divider method. A signal tracer will serve very well for detecting the slight hiss a few zeners show in the knee region, or the raucous racket at higher current levels indicating the zener should be discarded. Finally, a magnifying glass assists in detecting mechanical faults on the surface of the package.

The surplus market is low man on the totem pole. It's quite safe to expect a specific zener has something wrong with it, which brought it to the supplier and then you[2]. The testing operation is a sort of detective game played to find out if the fault will or will not interfere with its use in a piece of ham gear. This game can be played most productively if the goals are known. First, does it show semiconductor properties at all? Second, what do they seem to be? Finally, does a closer inspection show they are really there, and that obvious faults are absent?

Modern technology and the manufacturers have conspired to make this game more difficult than it might be. A given zener may be a double-anode device, usable in either direction. Or it may be a zener and a diode, practically the same thing but rather different in intent. And there is a chance it is an amplified zener: a zener and a transistor in one package. The amplified zeners seen so far have been high-power devices, but this may change any time.

A first inspection serves to eliminate broken zeners, ones with bad leads, cracked cases, and other faults. An obviously abused condition is certainly grounds for rejection. At this time the wattage can be estimated by comparison with known zeners and catalog descriptions. A few zeners are shown in **Fig. 2.** Low-wattage accurate zeners may be placed in large cases for better temperature control; high-wattage zeners are indicated by the provision of some means for mounting to a heat sink.

Then the power supply is set up with its negative output terminal to ground. A resistor is placed in series with its positive terminal, chosen to limit the current to near 10 milliamperes. A 40 volt supply would require about 4000 ohms, anything over a half watt would do. The zener goes between the output end of the resistor and ground. Regardless of its condition it cannot receive more than 10 mA; this is a safe arrangement.

The first test is to measure the lowest voltage across the zener at this current, trying both directions. If there is a polarity mark or band, the least voltage should be seen when the band or "cathode" end is toward negative ground. If the voltage is under about 0.6 volts, the device is not a zener and further testing is not required. If it is in this range, and if doubling the current by halving the series resistance from the supply produces only a small increase in voltage, the device is showing proper characteristics for a forward-biased silicon PN junction. If this cannot be achieved, it may be a faulty device, or it may be one of the more complex varieties, mentioned but otherwise carefully avoided in this article.

A breakdown test is now appropriate. The cathode end is turned toward the positive supply, and a measurement of voltage gives the approximate zener regulating voltage. If the resulting voltage is the power supply voltage, then no current is flowing and the device may be a rectifier whose inverse voltage, or a zener whose breakdown voltage, exceeds that available. A current doubling should, again, have very little effect on the stabilized voltage. This test indicates that the device shows zener characteristics.

Knowing the approximate zener voltage and wattage, the supply circuit can now be revised to bias the zener to anticipated normal operating conditions. At this time the dynamic resistance can be estimated by the hum reduction method or by the voltage change over current change method. Typical values for test current and dynamic resistance are available from most catalogs.

If the extra lead is not objectionable, the signal tracer can be left attached to the zener during these tests. With practice, good zeners can be sorted from bad ones almost by ear alone, on the basis of hum and noise. But if this has not been done, a final check for noise should be carried out. Raucous, splattering noise indicates immediate disposal of the zener. A fine-textured hiss at low current levels is permissible, unless it shows a tendency to increase with time or current. Larger zeners should be firmly rapped with an insulating rod to check for loose internal connections.

Zeners that have passed all tests might be marked with fast-drying modeling paint, in resistor color code, as to their values. The paint will also serve to indicate that they have passed a fairly comprehensive test.

. . . W2DXH

Bibliography

There is not very much literature available on zener diodes. Most of it tends to be rather condensed for engineering purposes. If you can find some to read, don't hurry. The usual engineering training includes lots of math and theory, so that the brief accounts carry much more information than at first meets the eye. Try to find more than one of these:

1. Millman & Taub: *Pulse, Digital and Switching Waveforms.* McGraw-Hill, 1965, p. 185-189.
2. Cutler: *Semiconductor Circuit Analysis.* McGraw-Hill, 1964, p. 564.
3. Surina & Herrick: *Semiconductor Electronics.* Holt, Rinehart & Winston, 1964, p. 304-312.
4. Littauer: *Pulse Electronics,* McGraw-Hill, 1965, p. 120-121.

Also see:

Motorola *Silicon Zener Diode and Rectifier Handbook.*
International Rectifier *Zener Diode Handbook.*

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[2] Of course, many zeners reach the surplus market as manufacturers' over-run, production ends, etc. These zeners, which are available from many suppliers, are generally good, new diodes. *Ed.*

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5A Insul Base

PRV	
50	.10
100	.20
200	.40
400	.60
600	1.00
800	1.25

TOP HAT & EPOXIES

PRV	750MA
50	.05
100	.07
200	.09
400	.12
600	.20
800	.25
1000	.50
1200	.65
1400	.85
1600	1.00
1800	1.15
2000	1.35

SCR's

PRV	7A
50	.35
100	.60
200	.90
300	1.35
400	1.75
500	2.25

SCR'S TO-5 TO-18

PRV	1 AMP	350 MA
15	.25	.15
30		.30
60	.70	.50
100	.90	.70
200	1.10	.90
300	1.25	1.00

TRANSISTORS

PNP silicon epitaxial low leakage transistor in TO-18 package. Similar to 2N2185 30 volts at 150 mw. **3/$1.00**

Similar to 2N329A general purpose PNP epitaxial transistor in TO-5 pack. Low leakage 30 volt unit with a 400 mw dissipation rating and B 30-80. Comp. with a $9 value. **4/$1.00**

Similar to 2N3060, a 60 volt silicon PNP in TO-46 pack has a B of 30 with 4 W dissipation. Used in DC amplifiers, high voltage work and audio systems. **4/$1.00**

Similar to 2N1640 bidirectional transistor, a TO-5 silicon unit. in which the emitter and collector are interchangeable. **40¢ each**

Similar to 2N339-2N341, etc. High voltage medium power units. NPN silicon. **7/$1.00**

Similar to 2N547A, B and C, etc. TO-5 NPN Si unit with its own heat sink mounting. Picture A. **5/$1.00**

Similar to 2N728. A high frequency NPN TO-18 unit extending to the UHF range. **5/$1.00**

Similar to 2N545, a 5 watt NPN TO-5 high voltage unit used for fast switching. **5/$1.00**

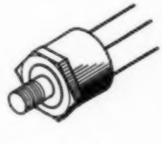
Similar to 2N721 PNP TO-18 silicon unit, 500 mw dissipation to 80 mc frequency. **4/1.00**

Similar to 2N1648 NPN high voltage 20 watt silicon unit used in power output stages and power transistor drivers. **2/$1.00**

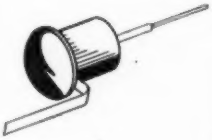
Similar to 2N2875 PNP silicon 20 watt power transistor with cut off frequency to 30 mc. Picture C. **2/$1.00**

Similar to 2N2885 NPN and TMT8035 PNP microtransistors. 75 mw power at high frequencies. **Both units $1.00**

Similar to 2N247 PNP germanium. Good for rf work. **10/$1.00**



A



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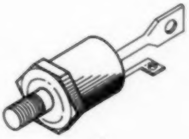
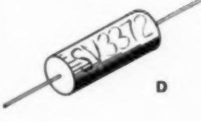


C



D

Similar to 2N255 20 watt PNP germanium power transistor in TO-3 case. **4/$1.00**

Similar to 2N327A PNP silicon TO-5 unit used in audio. **6/$1.00**

Similar to 2N519 silicon PNP unit used in rf circuits. **10/$1.00**

Similar to 2N389, 424, etc. 85 watt high voltage NPN silicon unit in TO-53 case. **75¢ each**

Similar to 2N1209, 2N1212, etc., with similar electrical characteristics in 11/16" stud package. **75¢ each**

FET'S N channel type similar to C610 used as amp, switch, chopper—very high input Z. **$1.25 each**

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1N429 6 volt double anode regulator. 2 watts. **5/$1.00**

SV176 7 volt reference. **5/$1.00**

Silicon bilateral switch (picture B). Replaces two SCR's by firing in either direction when breakdown voltage exceeded. Used in light dimmers, etc. **2/$1.00**

Silicon voltage references (Picture D). There are a series of precision regulators designed to operate under extreme conditions up, similar to SV140, SV3207, etc. **50¢**

1N252 a high frequency silicon diode used to 1000 mc. May be used as discriminator or detectors. PIV of 20 volts. **10/$1.00**

S284 similar to 1N252 but with PIV of 30 volts. **10/$1.00**

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Microdiodes similar to MD27, etc., up to 200 PIV at 30 μa. These are switching diodes with a short recovery time (.3 μsec). **6/$1.00**

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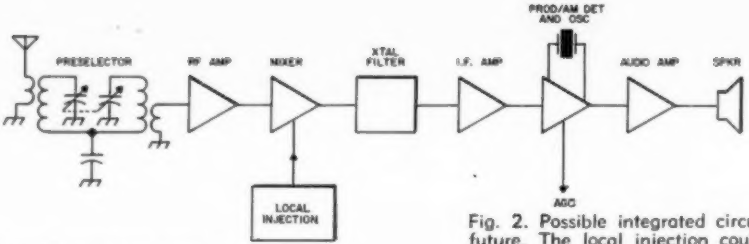

Fig. 2. Possible integrated circuit receiver of the future. The local injection could be a frequency synthesizer or conventional oscillator.

(Continued from page 4)

tional components. But these schematics look very odd to a person used to conventional tube or transistor circuits. They seem to contain an awful lot of transistors. There's a good reason for this. Transistors are the cheapest IC components to make—and they take up less area than other components. Low-value resistors (it's difficult to make resistors over 50 kΩ with monolithic IC's) are next smallest. Capacitors take up the most area so they are most expensive components to make. Since IC chips are small, capacitors over 500 pF are rare. So far, no one has developed a practical way to make IC inductors, so coils have to be outside the IC package.

These facts have meant that IC designers use as many transistors as possible and few resistors and capacitors. This is quite different from conventional practice, but isn't necessarily a disadvantage—once you become familiar with IC practice.

Devices using integrated circuits are usually simplest when they use two power supplies, one with a positive ground and one with a negative ground. This helps avoid the complicated bias networks and large decoupling capacitors that would otherwise be necessary with so many interdependent transistors.

Linear or digital?

In terms of use rather than construction, there are two types of integrated circuits. *Digital* IC's are the multivibrators, gates, counters, dividers, and so forth used in computers. Most engineering attention up to now has been focused on these digital IC's since they can simplify the construction of computers tremendously. Digital IC's have many possible ham uses: keyers (such as the Kindly Keyer in the July 73 and the Micro-Ultimatic in the June 73. Both of these keyers use very inexpensive Fairchild epoxy-case IC's: $1.50 and 80¢ for example.), dividers (as for getting 1 kHz markers from a 100 kHz crystal standard), counters (frequency meters that count the number of cycles per second), control circuits, mixers and detectors. Expect 73 articles on these topics in not too long.

Linear IC's are the other type of integrated circuits. They are amplifiers. A simple six meter converter using linear IC's was described by W3HIX in the October 1965 73. Until recently, linear IC's have been very expensive. However, the prices are dropping rapidly so we can expect to see more and more of them in hi-fi sets, radios and TV's. In fact, one RCA TV set already uses a single linear IC for its sound *if* amplifier and GE has just announced a linear IC for less than $1.00 in quantity.

Linear IC's are used in applications familiar to every ham, unlike digital ones, so linear IC's seem more interesting to most of us. They can be used for amplifiers, oscillators, mixers and much more.

IC's are of many types. Some are simply conventional amplifiers in small packages, but the most interesting and promising ones are quite different. The basic configuration for many IC's is the differential pair shown in **Fig. 1.** This circuit was chosen because it's very versatile, uses few high-value resistors or capacitors, and has excellent temperature stability since the transistors are matched. Differential amplifiers can be used as oscillators, amplifiers from dc to VHF, linears, frequency multipliers, mixers, product detectors, signal generators and so forth. They can be used in either push-pull or single-ended, and can easily be adapted for squelch or gain controls.

The constant current source shown in **Fig. 1** is usually included in the IC. It consists of a transistor regulator and a few diodes. Emitter followers, cascade amplifiers and other refinements are often included in the IC to increase gain or input impedance or for other reasons. Lots of terminals (10 to 14) are connected to vital points in the circuit so that the IC can be used in many ways: ac or dc input or output coupling and AGC or squelch terminals, for instance. IC's come in small (¼" x ½") flat packages and in cases similar to transistors.

IC's are made in widely different configurations, gains and frequency responses. They are made for many uses. Most are considerably more complex than the one shown in **Fig. 1.** A typical linear amplifier is the RCA CA3005. With external tuned circuits, it can give 20 dB of gain at 100 MHz with +6 volts on the collector end and −6 volts on the emitter end.

How Will IC's affect ham radio?

Ham *operators* will benefit from the IC's that turn up in their commercial equipment in a number of ways: increased reliability, more features, better performance, smaller size, less weight, lower power consumption—and lower prices. It probably won't be long before we see IC's in ham equipment made by progressive manufacturers. A single IC can replace the tubes, transformers, resistors and capacitors associated with them in a conventional *if* amplifier: Selectivity in modern equipment is generally provided by crystal or mechanical filters, but the spurious responses that sometimes pop up in odd places with narrow-band filters could be a problem. Nevertheless, they can be taken care of. In fact, the tremendous cheap gain available with IC's means that resistor-capacitor shaping and feedback networks can provide considerable selectivity, even at 455 kHz or higher.

IC detectors and audio amplifiers also should become popular in not too long. It'll probably be a bit longer before IC's are used in rf stages. They can't reduce the size of front ends too much, but they do have some features to offer. The low noise, high gain and high input impedance of IC's means that designers can build fairly high selectivity into the tuned circuits before the first rf amplifier. IC's can also give exceptional AGC without complicated external circuitry.

The ham *builder* will find that integrated circuits hardly end his fun. Most IC's now available are building blocks, not complete units. They can be put together in many ways. Soon IC's will be very cheap. They're already easy to wire up. In not too long we'll be able to use more complex (and desirable) circuitry than we've tried in the past, yet still have inexpensive and easy-to-build equipment. We have plenty of building to do before we all become operators (or TV watchers) instead of experimenters and builders.

The future of integrated circuits is very bright. They have plenty to offer all of us. Learn a little about them now so you won't be lost as they become more popular. Don't stand in the corner with your back to everyone crying "Tubes forever!" (or even "transistors forever!") until you've been passed by.

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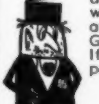

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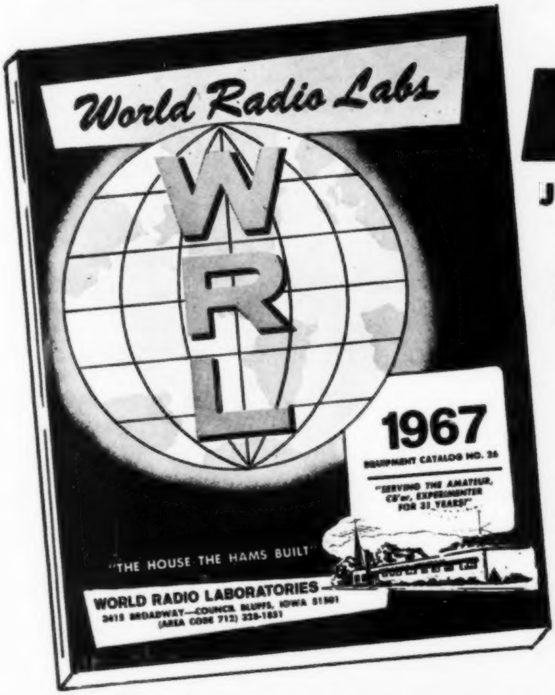
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